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Survey of Operating and Financial Characteristics of Community Water Systems

Temple, Barker and Sloane, Inc, Wellesley Hills, Mass

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CHAPTER ONE

INTRODUCTION AND BACKGROUND

INTRODUCTION

During the last year and a half the Environmental Protection Agency, Office of Water Supply, has been conducting a series of research activities to analyze the impacts of the Safe Drinking Water Act of 1974 and its associated regulations. One of several components which has been undertaken by Temple, Barker & Sloane, Inc., is a survey of community water systems[1] to improve and expand upon existing operating and financial information on the nation's drinking water suppliers. The purpose of this report is to present the results of the Community Water System Survey and to document the information collection process.

The intent of Congress in passing the Act was to insure the high quality of the drinking water supplied to consumers regardless of the size or other characteristics of the water system providing the water. On the other hand, such insurance carries with it potential treatment requirements and additional costs to water systems (and ultimately to consumers) which might be infeasible given the existing financial profile of certain water systems. One of EPA's objectives has been to determine what financial impact the Congressional legislation and related regulatory guidelines would have on water suppliers and consumers. Such determination would permit the Agency to promulgate final regulations which would be sufficiently realistic to be implementable and would, at the same time, satisfy the intent of Congress.

---

[1] *Water systems serving twenty-five persons or more and/or maintaining fifteen or more service connections on a year-round basis.*

THE NEED FOR A SURVEY

When the Proposed Interim Primary Drinking Water Regulations were issued in the spring of 1975, a number of questions were raised which helped to focus EPA's research efforts. Among them were queries concerning:

- The costs of complying with the regulations
- The differences in the degree of the impacts which would be felt among different types of water systems
- The financial profile of the water utility industry
- The economic and financial feasibility of implementing the regulations.

In the process of addressing these questions through a study conducted by Energy Resources Company,[8] it became clear that the most substantial relative cost impacts would probably occur among small systems serving 25 to 500 people. In addition, it appeared that the relative impacts were distributed unevenly among systems of different ownerships or water source. The ERCO study also indicated that there was a severe lack of detailed operating and financial data for systems serving fewer than 10,000 people. As a result, EPA determined that a survey should be conducted which would provide background information on the general operating, treatment, and financial practices of water systems of all sizes, ownerships (i.e., public and private), and water sources (i.e., ground, surface, purchased, or mixed sources).

---

[8] *"Economic Evaluation of the Promulgated Interim Primary Drinking Water Regulations" for EPA, October 1975*

The results of the survey would then be used in several ways, including:

- Improving the understanding of the financial position of small water systems for EPA analysis of regulations
- Updating and validating existing data which has been used in EPA's analyses and to develop a financial impact analysis model of the water utility industry
- Providing a more complete basis for evaluating the feasibility and impacts of potential new regulations under the Safe Drinking Water Act.

SURVEY SAMPLE

TBS conducted the survey during the spring of 1976 and completed the analysis of survey results in the fall of 1976. The selection of water systems to participate in the survey was based upon the need to obtain reliable data from small- and medium-sized systems and verify and update existing information on large systems. The objective was to include about 1,000 water systems in the final sample which were representative of the industry in terms of population served, location, ownership, and water source.

In order to achieve the objective, an original sample of 2,130[3] community water systems serving between 25 and 100,000 people was randomly selected from the EPA inventory of approximately 43,000 systems. In addition, all 232 systems serving over 100,000 people were included as part of the original sample.

---

[3] *The original sample consisted of about one thousand systems stratified by EPA region and size and controlled by ownership and water source. An additional group of 1,000 with similar characteristics were selected as alternates.*

Once the survey was completed, the final participating sample (those systems which returned completed questionnaires) totalled 984 systems. Of these, 48 percent serve fewer than 1,000 people, 22 percent serve between 1,000 and 10,000, and 9 percent serve between 10,000 and 100,000 residents. Finally, 203, or 21 percent, of the total are large systems, those which serve over 100,000 residents.[4]

Among the participating systems publicly-owned systems are more frequently represented. Sixty-three percent (622) of the final sample is publicly-owned. Of the 362 systems which are privately (investor) -owned, 75 percent serve fewer than 500 people.

The distribution of systems by region for all sizes is relatively even. Region IV, which covers eight states in the East South Central and South Atlantic area of the country, has the largest representation with 117 systems. Region X, the Northwest, which includes three states, has the lowest with 76 sytems. The following table presents the distribution of systems by size and region; the map following illustrates the regional subdivisions.

---

[4] *Eighty percent of the population served by community water systems receives water distributed by these large systems; of the existing 230 sytems, 90 percent participated in the survey.*

Table I-1
DISTRIBUTION OF SYSTEMS BY SIZE AND REGION
COMMUNITY WATER SYSTEMS SURVEY DATABASE

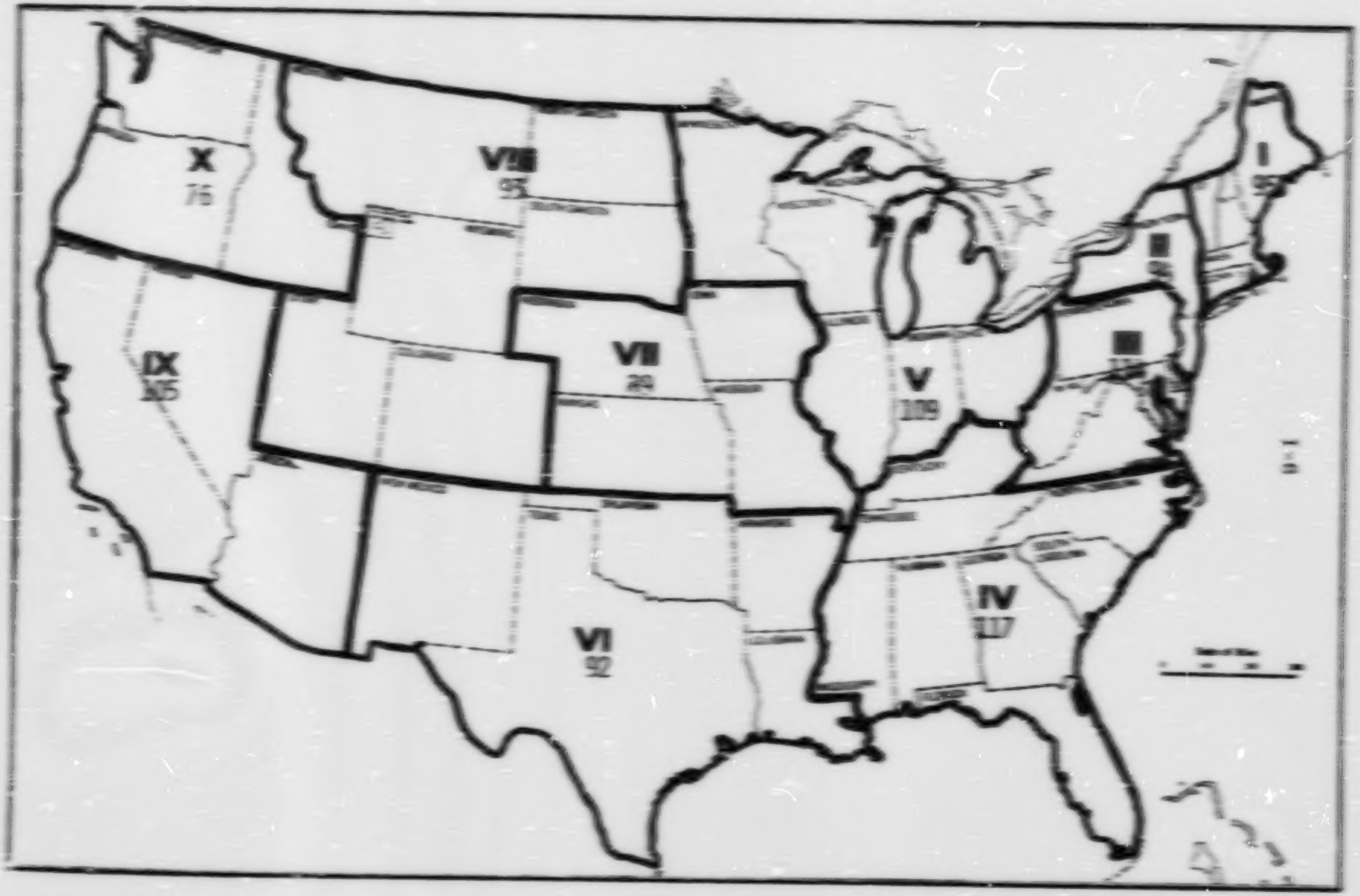
	Population Category									
EPA Region	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 mil	Total
Region I	19	20	10	6	7	8	11	14	0	95
Region II	16	19	4	10	7	2	9	26	1	94
Region III	27	21	6	11	7	4	11	24	3	114
Region IV	14	26	10	10	4	6	6	41	0	117
Region V	12	19	15	15	7	5	7	26	3	109
Region VI	11	24	6	27	6	1	7	13	2	97
Region VII	6	26	17	14	6	2	5	12	1	89
Region VIII	4	35	12	16	8	3	10	5	0	93
Region IX	15	24	8	5	5	8	14	25	1	105
Region X	23	19	7	7	6	3	5	6	0	76
TOTAL	145	235	95	116	63	42	85	192	11	984

STRUCTURE OF THE REPORT

The chapters which follow are intended to provide information and documentation in a manner which makes the survey results usable and their source and validity clear. Chapter Two summarizes the major results of the survey. Chapter Three describes the methodology for data collection and analysis. Chapters Four and Five cover the general and operating characteristics of community water systems. Chapters Six through Eight discuss the financial characteristics of participating systems. Finally, the Appendix provides references to other materials on water utility finances as well as copies of the survey questionnaires and coding procedures.

Exhibit I-1

EPA REGIONS—DISTRIBUTION OF SYSTEMS


X
76
IX
105
VIII
95
VII
20
VI
92
V
109
IV
117
I
II
III

CHAPTER TWO

SUMMARY

The results of the Community Water System Survey provide economic and operating information about water systems of all sizes and operating complexity. The information is valuable to on-going research activities in several areas related to drinking water supplies and lends itself to varying levels of detail in presentation. The purpose of this summary is to cover the major findings in a brief manner for the readers who may not need further detail, and to establish a context for the discussion in other chapters. The three perspectives selected for the summary are:

- The structure, size, and economics of the water supply industry at the national level, which can be inferred from the survey results.
- The operating and fiscal characteristics of typical water systems in each of nine size categories.[1]
- The major financial patterns and differences among systems which are indicated by the survey results.

The first two of these perspectives summarize the results of the survey in ways which are not done in the later chapters. First, the other chapters discuss results in terms of the sample population; this is the only chapter which introduces a national context. Second, the later chapters generally discuss results individually, on an item-by-item basis; this is the only chapter which presents an integrated and complete profile of typical water systems in each size category.

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[1] *For purposes of analysis and reporting, water systems have been grouped according to the residential population they serve: 25-99; 100-499; 500-999; 1,000-2,499; 2,500-4,999; 5,000-9,999; 10,000-99,999; 100,000-999,999; over 1 million.*

In reviewing the summary chapter, it should be recalled that the data are based on 984 individual water systems. As one would expect, there are significant differences in the characteristics reported across size categories. Within each size category, there is also a wide range of responses, even among systems of similar size and characteristics. Some of the reported differences can be attributed to variations in demand levels, location, water source, customer mix, and treatments used. Other differences can not be explained by the data obtained in this survey and may reflect variations in the historical development of the water systems, local conditions, individual customers, and so on. The diversity of characteristics in water production and distribution is reflected in similar differences in the capital expenditures, operating costs, and revenue requirements which were reported.

One must be mindful of this variability when interpreting and using the results of the survey. The later chapters facilitate interpretation by addressing the variability explicitly, often in terms of means, medians, and standard deviations. In reading this chapter the reader should understand that the typical system characteristics are just that--"typical" for systems of a certain type, but not uniformly true for all of them--and that the national extrapolations are based upon the averages provided by the survey results.

THE WATER SUPPLY INDUSTRY AT THE NATIONAL LEVEL

The water supply industry includes thousands of individual community water systems ranging in size from those serving less than a hundred people to some serving over a million people. Water systems all produce the same product, regardless of size; they also have in common the same basic production and distribution processes, although they vary in complexity and sophistication. The economics of operation and the financial capabilities of firms, on the other hand, are not at all consistent across the range of sizes and favor the largest systems.

INDUSTRY PROFILE

Some of the survey data have been extrapolated to the national level to provide a profile of the industry as a whole. The extrapolation is based upon the distribution of systems in the EPA Inventory of Community Water Systems. The Inventory served as the sampling population for the survey and provided the only statistics available on the number and size distribution of water systems currently operating nationwide. Adjustments have been made to the number and distribution of systems indicated by the Inventory to include new systems which would have been formed in the last year, and to exclude duplicates, systems which serve under 25 permanent residents, and systems which no longer exist.

On that basis it is estimated that approximately 35,000 community water systems were in operation in 1976, serving a total population of 192 million.[a] The breakdown of the total estimate into the nine system size categories used in this report is shown in Table II-1.

---

[a] *The definition of the water supply "industry" as used in this report includes all community water systems which: a) serve 25 or more year-round residents or have 15 or more connections serving permanent residents; b) are investor-owned or publicly-owned at the local or state level; and c) are located in the contiguous 48 states or Washington, D.C. This definition excludes the following system categories because representative data was not obtained for them: a) those which serve only non-residents or which serve only wholesale and no retail customers; b) those which are federally-owned; and c) those located in the U.S. territories, Alaska or Hawaii.*

Perhaps the most important observation to be made from the table is simply the significance of small systems: half of the total number of systems, over 18,000, serve fewer than 500 people. At the other end of the scale, the systems serving over 10,000 people (the ones to which most of the public data relate) comprise only 8 percent of the total systems.

The population figures on the table, as expected, display exactly the opposite pattern. Despite their large numbers, the small systems serving fewer than 500 people account for less than 2 percent of the population served by water systems in the country. In fact, the data indicate an "80 and 8" pattern--8 percent of the systems, in the three largest sizes, account for 80 percent of the population. The opposite also holds, that 80 percent of the systems at the smaller end, account for only 8 percent of the population.

Table II-1

NATIONAL ESTIMATES OF SYSTEMS AND POPULATION SERVED, 1976*

	Population Category									
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	>1million	Total
No. of Systems	6,308	11,714	4,932	4,850	2,496	1,646	2,442	232	11	34,631
percent	18%	34%	14%	14%	7%	5%	7%	1%	**	100%
Population Served (millions)	0.4	2.8	3.4	7.6	8.7	10.4	73.0	59.9	26.2	192.2
percent	**	2%	2%	4%	4%	5%	38%	31%	14%	100%

*Based on EPA Inventory (adjusted) and Community Water Systems Survey, TBS, 1976. Excludes systems which are federally-owned, directly serve fewer than 25 permanent residents, or are located in the U.S. territories, Alaska or Hawaii.

**Less than one percent.

A graphical profile of the industry in terms of system size, ownership, and primary water source is shown on the following page. The first two graphs illustrate the pattern described above in terms of numbers of systems versus number of people served in the small and large system size categories. The other major points illustrated in Figure II-1 are:

- publicly-owned systems make up 56 percent of the systems and serve 84 percent of the population;
- investor-owned, or private, systems of course show the reverse, with 44 percent of the systems and only 16 percent of the population;
- ground water systems number 75 percent of all systems but produce only 39 percent of the average daily water production of the U.S.;
- purchased water systems are about even, at 12 percent of the systems and 12 percent of the water produced, treated, and distributed;[8] and
- surface water systems account for only 13 percent of the systems but 49 percent of the daily water production.

The breakdown by system size category of two key operating statistics at the national level are presented in Table II-2. One of those items is the average daily production of systems. The mean, or average, production level

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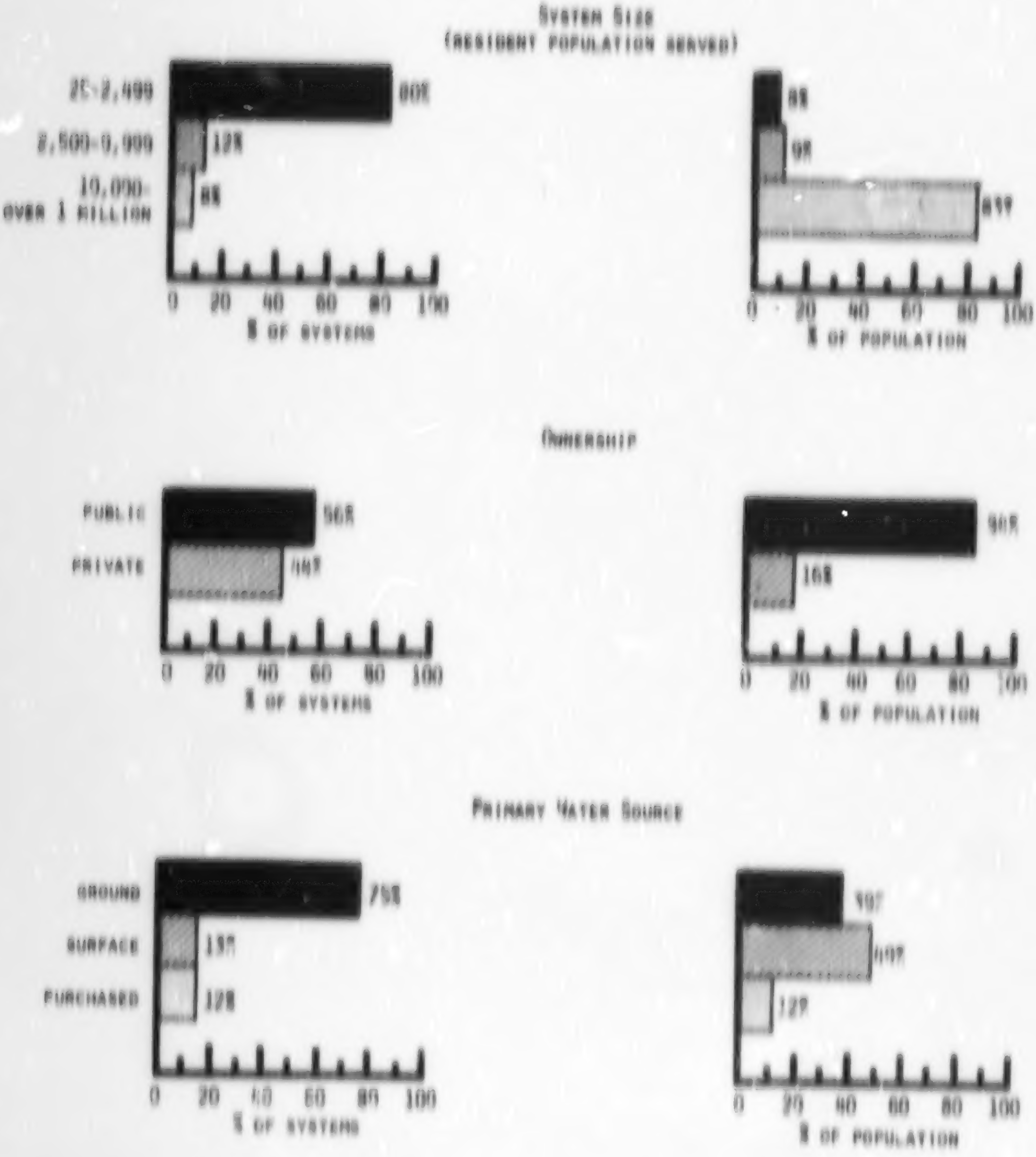
[8] *Of course, purchased water is originally either ground or surface water produced and sold twice, once to the purchased water system and finally to the ultimate customer. To some degree, this volume is included twice in the figures here which are based upon the total water production and sales of each system. At the same time, however, a large portion of purchased water is bought from systems which sell water on a wholesale basis only (e.g. Metropolitan Water District of Southern California and the Metropolitan District Commission of Boston). These "wholesale only" systems were not included in the survey and as a result the water they sell appears only on the production reported by "Purchased Water Systems."*

Figure II-1
NATIONAL PROFILE OF WATER SYSTEM CHARACTERISTICS



NOTE: TOTAL SYSTEMS = 34,631; POPULATION = 192.2 MILLION;
DAILY WATER PRODUCTION = 23,300 MGD

ranges from .006 MGD (million gallons per day) for systems serving 25 to 100 people, to 496.660 MGD for systems serving over 1 million people. A production level of 1 MGD is characteristic of systems serving approximately 7,000 people.

The median data presented in Table II-2 illustrate the relationship of the mathematical average results and the typical (mid-point in the range) reported figures which is generally evident in all of the survey results. In the case of the average daily production presented here, the median or typical levels are approximately 15 to 40 percent lower than the mean levels across the size categories.

The second operating statistic shown in Table II-2 is the breakdown of water source within each size category. These numbers show the predominance of ground water systems in the small system sizes and therefore in the total industry. They are presented here primarily for reference by those wishing to evaluate regulations which would affect systems differentially by source.

Table II-2

SELECTED OPERATING CHARACTERISTICS
OF COMMUNITY WATER SYSTEMS
NATIONAL ESTIMATES BY SIZE CATEGORY
1976

	Population Category									
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million	Total
Number of Systems (total)	6,308	11,714	4,932	4,850	2,496	1,646	2,442	232	11	34,631
Average Daily Production (MGD)										
Mean	.006	.025	.075	.200	.480	.921	5.059	48.003	496.660	-
Median	.004	.019	.063	.160	.414	.731	3.027	30.948	356.700	-
Number of Systems by Primary Water Source										
Ground	5,930	9,488	3,452	3,347	1,448	1,053	1,270	65	1	26,054
Surface	63	586	888	824	674	428	757	137	10	4,367
Purchased	315	1,640	592	679	374	165	415	30	0	4,210

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*Based on EPA inventory (adjusted) and Community Water Systems Survey, TBS, 1976

FINANCIAL SCOPE OF THE INDUSTRY

The application of the survey's financial results to the numbers of systems estimated above provides a projection of the industry's national financial scope. One of the chief conclusions which results from such projections is that the industry is one of the nation's most capital-intensive in terms of asset requirements per dollar of revenue. Other industries range from less than one dollar to about four dollars of assets per revenue dollar--airlines at $1, railroads at $2, telephone companies at close to $3, and electric utilities at $3 to $4. Water systems, however, according to the survey data (and confirmed by other sources) are operating at approximately $6 to $10 of assets per dollar of revenues. The reason is a combination of low revenues, high investment, and long physical lives for the assets (often fifty years and more).

The national financial projections for the industry based upon the survey data are displayed in Table II-3. As the table shows, the industry's projected annual revenues were approximately $4.9 billion in 1975. For residential customers that amounted to about $18 per capita for the year. Revenues from all sources, for perspective, were $25 per capita.

For the same year, 1975, the industry's total assets are projected to have been $40.6 billion based on the survey averages.[4] That level is significant on any scale, although it is by no means the largest utility industry. Total assets for water systems amount to approximately half the investment of the telephone industry and one-fourth that of the electric utilities. At an individual level, total water system assets across the country average $258 per capita for the population served.

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[4] *Again, note the "industry" definition is community water systems which serve retail customers. That excludes certain federal and other dams, reservoirs, and distribution and treatment systems which would add significant revenues and assets to these totals. See footnote on page II-3.*

The industry's capital expenditures for the six-year period, 1970-1975, are estimated to have been approximately $7.6 billion based upon the reports of the individual systems in the survey. On an annual basis that was an average of $1.3 billion per year. The sources of funds for capital projects, according to the survey responses, are estimated to have been 28 percent from internally-generated funds and 72 percent from the capital markets.

Table II-3

NATIONAL FINANCIAL PROFILE
COMMUNITY WATER SYSTEMS*
(totals for all systems in millions of dollars)
1975

		25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	≥1 Million	Total
Revenues	$	14	88	99	198	221	249	1,061	1,011	556	4,885
Total Assets	$	107	1,148	1,046	1,030	2,095	2,096	20,947	14,703	4,634	48,570
Capital Expenditures, 1970-1975 Cumulative	$	13	216	164	437	619	610	2,676	2,003	562	7,570
External Financing, 1970-1975 Cumulative	$	2	166	107	356	381	447	1,500	1,573	386	5,458

*Based on Community Water System Survey results--mean values. Excludes systems which are federally-owned, directly serve fewer than 25 permanent residents, or are located in the U.S. territories, Alaska or Hawaii.

TYPICAL SYSTEM CHARACTERISTICS IN EACH SIZE CATEGORY

The information presented above portrays an unusual industry, one dominated in numbers by very small systems, and at the same time one with relatively high investment demands. This section presents a profile of the individual systems which make up the industry.

The data is presented in terms of typical systems in each of the nine size categories used in the analysis. The values which are used here are equal to or near the median values in the survey data. Accordingly, these profiles reflect situations which are "typical." For any given item approximately half of the systems will have reported higher values and half will have reported lower values. It should be noted however that the typical system financial statements do not literally include the median values reported for each of the individual line items. The purpose of these financial statements is to describe a financial profile which is both representative of relatively common situations and is internally consistent. The reported median values for each item may each be from different water systems. Therefore, some values have been modified slightly in order to contrast an income statement and balance sheet which are based on reported values but which are also logical and consistent.

Some selected operating characteristics of typical systems in each size category are listed in the table below. As the ownership and age rows indicate, the large systems tend to be old and publicly-owned, while the small systems serving fewer than 500 people are generally much newer and are privately-owned. These small systems have also much less complex operations than the large systems. The systems in the smallest categories typically use ground water with no treatments at all and often serve only residential customers. The systems serving 500 to 100,000 people have more diversified customer groups but still tend to use ground water with only one

Table II-4

SELECTED CHARACTERISTICS FOR A TYPICAL WATER SYSTEM IN EACH SIZE CATEGORY

1978*

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	>1 million
Age (Years)	11	16							
Ownership	Private	Private	Public	Public	Public	Public	Public	Public	Public
Population Served	50	225	694	1,500	3,535	6,000	25,000	181,000	1,500,000
Water Source (Surface, Ground, or Purchased)	GRND	GRND	GRND	GRND	GRND	GRND	GRND	SURF	SURF
Daily Production (MGD)	.034	.029	.083	.160	.424	.731	3.027	33.940	355.700
Residential Deliveries Per Capita Per Day (Gallons)	62	77	74	84	73	81	93	74	79
Number of Non-Residential Customers	3	1	14	16	75	116	422	3,900	47,797
Treatments**	None	None	Disinfection	Disinfection	Disinfection	Disinfection	Disinfection	Disinfection Filtration Corrosion Control	Disinfection Corrosion Control Coagulation And Sedimentation

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*Based on median values from Community Water Systems Survey.

**Treatments used by at least 50 percent of the systems in the size category (e.g., only 30 percent of system in smallest category disinfect their water).

treatment, disinfection. Only in the largest two size categories were surface water and more extensive treatments reported by over half the survey respondents.

A set of typical water system income statements and balance sheets as determined from the survey data, is presented in the two tables below.

Table II-5

INCOME STATEMENT

FOR A TYPICAL WATER SYSTEM IN EACH SIZE CATEGORY--1976*

(thousands of dollars)

Population Category

	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Annual Revenues	$1.1	6.6	16.0	35.6	86	156	540	4,600	30,000
Expenses									
O&M	.7	3.6	7.5	22.1	51	91	283	2,100	12,300
Depreciation	.2	1.3	2.6	3.1	16	17	29	320	3,400
Taxes & Payments in Lieu of Taxes	0	.4	1.3	1.0	.7	17	101	600	6,000
Other	.1	.5	1.1	3.1	8	5	3	90	-
Total Oper. Exp.	1.0	5.8	12.6	29.3	76	129	416	3,100	21,700
Interest	-	-	2.8	6.0	10	20	60	900	6,700
Total Expenses	1.0	5.8	15.4	35.3	85	149	476	4,000	28,400
Profit or Surplus	.1	0.8	0.6	0.3	1	7	64	600	1,600

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*These figures generally represent the median levels reported and do not reflect the wide degree of variations among the individual systems.

The income statements for the various size categories highlight the range and diversity of systems in the industry. For example, the typical system in the smallest size category has fewer expense accounts than the larger systems and revenues which are only $1,100 per year. The typical system serving 5,000 to 10,000 people per year in contrast has revenues of over $150,000 per year, and the typical system serving over 1 million people has revenues of $30 million per year.

One cannot help but notice as well the relatively low operating budgets of the small systems, considering the number of people they serve and the volume of water they pump to their customers daily. The annual operating and maintenance (O&M) expenses for these typical systems are only $700 for a system serving 60 people, $3,600 for one serving 240 people, and $7,500 for one serving 700 people. Except for miscellaneous other expenses, the remainder of the system costs, about a third, are essentially fixed costs--depreciation, taxes or payments in lieu of taxes, and interest.

The data here do not highlight the economies of scale which exist in virtually every expense category. The data, if recalculated on the basis of dollars per thousand gallons produced, would reveal significantly higher costs in the small system sizes than in the large sizes. The system serving 100 to 2,500 people typically have the highest unit costs, usually 30 to 100 percent higher than systems serging 10,000 to 1 million people.

Table II-6

BALANCE SHEET

FOR A TYPICAL WATER SYSTEM IN EACH SIZE CATEGORY--1976*

(thousands of dollars)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
					ASSETS				
Gross Plant:									
Production/Treatment	[illegible]	19.7	39	85	140	310	1,420	12,300	104,000
Distribution System	[illegible]	[illegible]	67	155	510	840	4,290	30,500	266,500
Other	[illegible]	[illegible]	16	30	120	130	800	6,400	81,600
Total Gross Plant	19.7	65.7	161	270	770	1,280	6,500	49,200	452,000
Depreciation	(3.3)	(5.8)	(27)	(40)	(100)	(230)	(1,650)	(11,000)	(125,950)
Current Assets	[illegible]	[illegible]	[illegible]	55	80	70	650	2,800	11,700
Other Assets	[illegible]	[illegible]	[illegible]	20	40	80	250	2,400	20,000
Total Assets	$19.1	70.0	141	305	790	1,185	5,750	43,500	373,000
					CAPITAL & LIABILITIES				
Long-Term Debt	[illegible]	[illegible]	52	115	260	330	1,800	12,500	131,600
Other Capital	[illegible]	56.0	50	140	510	810	3,800	29,000	230,400
Current Liabilities	[illegible]	[illegible]	21	50	20	50	150	2,000	11,030
Total Capital & Liabilities	$19.1	70.0	141	305	790	1,180	5,750	43,500	373,000

* These figures generally represent the median levels reported and do not reflect the wide degree of variation among individual systems.

The balance sheet data (Table II-6) for typical system affords similar comparisons. The total asset balances are approximately ten times the annual revenue levels reported above, so the range is from approximately $10,000 for the typical system serving fewer than 100 people to over $370 million for one serving over 1 million people. For all sizes, however, some patterns remain relatively constant. One example is the level of distribution system assets; it is the highest asset category for all system sizes. That one item accounts for over half of total gross plant assets for the typical system in all but one size category.

On the capital side of the balance sheet, the major item shown for these typical systems is "other capital." That represents "equity" in the form of paid-in capital, assessments, cumulative retained earnings and other contributions. Long-term debt is typically about one-third of a system's total capital.

MAJOR FINANCIAL PATTERNS

A number of patterns such as those described above have emerged from the survey data and help to characterize the economics of the industry. They are described throughout the report, topic by topic, and the major ones are also briefly listed below. Many can be observed in the typical system financial statements in this chapter as well. The major ones are:

REVENUES AND RATES

- A pattern of declining mean and median revenue rates with increasing system size, ranging from approximately 80 cents per thousand gallons produced for the smallest systems down to 57 cents for the largest.

- wide variation on revenue rates among systems, even of the same size, ownership, and water source, with some systems not charging at all for water and others charging over $2 per thousand gallons produced; and
- a higher, flatter pattern of reported rates for residential customers, with the mean rates ranging between 71 and 94 cents per thousand gallons delivered for systems serving fewer than 100,000 people, and dropping only as far as 54 cents for the largest systems.

OPERATING EXPENSES

- clear economies of scale in total system operating expenses (O&M, depreciation, taxes, and miscellaneous other expense), with expenses of 65 to 80 cents per thousand gallons for systems serving fewer than 2,500 people, dropping to 50 cents for systems up to 10,000 people, 40 cents for the next step up to 100,000 people, and 24 to 30 cents above that; and
- interest expenses which follow a similar pattern, from 23 cents for systems serving 100 to 500 people down to 5 cents per thousand gallons for the largest systems.
- operating surpluses or profits reported by approximately 70 to 80 percent of the publicly-owned systems in each size category, 40 to 67 percent of the private systems below the 2,500 population size, and 100 percent of the private systems above that size.

ASSETS

- a pattern of declining mean assets-to-production level requirements with increasing system size, dropping from mean rates in the two smallest sizes of $4.81 and $6.84, respectively, in assets per gallon of average daily production down to an average of only $1.02 for systems serving over 1 million people;
- a similar, but lower, pattern of median asset-to-production level requirements, declining from levels in the smallest two categories of $3.37 and $3.99 to $0.80 in the over 1 million population category; and

- an exception to the general patterns of declining costs to scale in the area of distribution system assets, which increase in dollars per connection with increasing system size, ranging from mean levels of $285 per connection in the smallest size category to $549 in the largest.

CAPITAL

- a capital structure which, for systems serving over 500 people, is approximately 20 to 40 percent long-term debt, and 60 to 80 percent equity, both for public and private systems (although many apparently have not carried all the contributions and other equity on their books); and
- a pattern of financing current capital expenditures approximately 20 to 40 percent from internal sources of funds and 60 to 80 percent from external sources, almost all of which is debt.

CHAPTER THREE

METHODOLOGY FOR DATA COLLECTION AND ANALYSIS

The primary objective of the survey was to present information which was representative of water systems of all sizes, ownership types and water sources, in all regions. The achievement of that objective was dependent upon selecting an appropriate sample and upon receiving a maximum number of completed questionnaires from the systems which were contacted. In addition, the validity of the results depended upon the verification of responses and upon the approach used in processing the data. These components:

- selection of the water system survey sample
- the survey procedures
- the data coding and review, and
- the data processing

all received particular attention and are described in the sections which follow.

SELECTING THE SAMPLE

Before describing the sampling procedure, there are a few terms and guidelines included below for purposes of clarity.

> *Community Water Systems*. The survey was intended to cover systems which provide regular service to residential customers. The possible health effects of contaminants in drinking water may differ for persons exposed over long time periods and those drinking the water briefly or intermittently. The Safe Drinking Water Act and the IPDWR describe the water systems

covered as "public" water systems.[1] These systems are further categorized as (1) community water systems--those which serve residents, and (2) non-community water systems which service transients or intermittent users.[2] The IPDWR further defines community water systems as those which serve at least 15 service connections used by year-round residents or which serve at least 25 year-round residents. The survey was confined to those systems which are classified as community water systems.[3]

Water System Size. Residential population served was the characteristic used to group water systems according to size. The number of year-round residents which are served by each water system was the basis for stratifying the survey sample and for analysing the questionnaire reponses.

Ownership. All systems in the sample are "public" insofar as they regularly provide piped water for human consumption to 15 service connections or 25 people. However, "public" systems include those which are privately (or investor) owned as well as those which are owned by a local government (a municipality, state, district, or authority). Public ownership, in the case of the survey, refers to systems owned by a local government.

Systems which are federally-owned and operated have been excluded from the survey sample. Since these systems are in a unique financial position, they are not representative of either the public or private segments of the industry. At the same time, there are few enough that a random sampling technique would not include a sufficient number of observations to report on as a separate category of systems.

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[1] *IPDWR--Interim Primary Drinking Water Regulations. Public water systems include both publicly and privately-owned systems which serve an average of at least 25 individuals at least 60 days out of the year.*

[2] *The reason for the distinction is that different regulatory considerations may apply to each.*

[3] *By using this definition to determine which systems should be included in the survey, those systems which only sell water on a wholesale basis were not included.*

Geographic Location. In order to insure adequate representativeness across the country, the basic geographic guidelines for the sample specified that about one hundred systems would come from each of the ten EPA regions (see map on page I-6). Approximately ten systems would be located in each of the contiguous forty-eight states. Alaska, Hawaii and the territories were excluded as a matter of convenience for the conduct of the survey.

Within the boundaries of these guidelines, a sample of community water systems was to be drawn which was representative of the industry along three dimensions:

(1) Size (nine population size categories: 25-99, 100-499, 500-999, 1,000-2,499 2,500-4,999, 5,000-9,999, 10,000-99,999, 100,000-1 million, ≥1 million)

(2) Ownership (public or private)

(3) Primary water source (surface, ground, or purchased)

The sample needed to be large enough to draw justifiable conclusions for the industry at the national level. At the same time, it was hoped that the responses would be adequate to draw conclusions at the regional level as well.

USE OF THE EPA INVENTORY

The sampling population was the EPA Inventory of water systems. The Inventory is a result of an original listing of public water systems compiled by the Public Health Service and expanded and updated through the cooperative efforts of EPA's national and regional offices. When the survey sample was drawn in January 1976, the Inventory contained about 43,000 systems; it is the only source which even approximates a comprehensive listing of all public water systems.

The following describes the sampling procedure:

1. Water systems in the inventory were first separated into community and non-community classifications as defined by the systems on a standard coding form used for entry into the inventory.
2. Community systems were further sorted by state, ownership, and size.
3. For those systems serving fewer than 100,000 people each, an equal interval sampling procedure by state was used to select a primary sample of 1,092 systems and an alternate sample of 1,042 systems with matching characteristics.[4]
4. All community systems in each state serving over 100,000 people, which appeared in the Inventory, were also included.
5. In order to eliminate any duplicate or ineligible systems, each regional office received a list of the sample systems under its jurisdiction.

This process produced a list of systems which was to be used to conduct the survey. Unfortunately, the efforts did not fully satisfy the needs for the survey master list. Even after screening for obvious duplications or errors, a certain number of water systems on the master list were found to have one or more omissions or inaccuracies. The major categories of problems encountered are listed below:

- Incomplete, inaccurate or missing addresses, telephone numbers, system names

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[4] *The purpose of the alternate list was to enable the substitution of systems with similar characteristics in the event that the system on the primary list was ineligible (not a community water system), nonexistent, uncooperative, or otherwise could not be used.*

- Misclassification as a community water system (e.g., resort, church, business convention center, fewer than 25 permanent residents)
- Systems no longer in existence (i.e., merged into another system, trailer park closed, etc.)
- Inaccurate population or ownership information

These problems delayed the completion of the survey; however, the documentation of water systems with these or other inaccuracies, has been submitted to EPA for use in its continuing effort to update and revise the inventory. Exhibit III-1, at the end of this chapter, is a summary of the distribution of systems according to the results of attempted contacts.

SUMMARY OF SURVEY PROCESS

The survey itself was conducted by Decision Research Corporation (DRC), a survey research group associated with Temple, Barker & Sloane, Inc. (TBS). DRC was responsible for all major components of the survey process, although DRC staff members consulted frequently with the TBS project team. TBS participated whenever necessary and appropriate during the entire course of the survey.

The major components of the survey process were as follows:

1. Two questionnaires were designed, pretested and revised, one for private systems and one for public systems;
2. A preliminary telephone call was made to each water system;

3. A five-page questionnaire was mailed to each system;

4. Follow-up telephone calls were made to encourage the return of the questionnaire, to clarify information on returned questionnaires and to interview by telephone those systems which had not returned their questionnaires;

5. The data were transferred to coding forms and keypunched.

6. The data was then processed through several cycles to produce tabulations which could be further analyzed.

Each of these steps is described briefly below.

QUESTIONNAIRE DESIGN AND TESTING

The questionnaire was designed to capture operating and financial information. Toward this end, an effort was made to formulate a questionnaire which was suitable for all size and ownership categories and which was short enough that the water systems could be likely to respond to all questions. It was necessary to develop two questionnaires, one for publicly-owned and one for privately-owned systems, in order to establish financial categories which were relevant to the systems' financial structures.

The questionnaire used to collect the data was reviewed and revised several times prior to mailing to the sample of water systems, for example:[5]

1. It was reviewed by EPA (national and regional Water Supply Office staff);

2. Four pre-test interviews were conducted with water systems in the Boston area;

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[5] *The questionnaires were reviewed through the standard federal government procedures for such surveys and received clearance from the Office of Management and Budget (OMB # 158-S78009--expires 10/77).*

3. It was reviewed by representatives of the water utility industry.

These procedures resulted in substantial improvements as questions were changed, added, and rephrased; and answer categories were clarified, and as much as possible, made to conform with staadard industry phraseology and record-keeping methods. (See Appendix A for copies of the public and private questionnaires).

PRELIMINARY TELEPHONE CONTACT[a] AND MAILING

To assure the largest possible return of questionnaires, a preliminary telephone call was made to each system to determine:

1. if the sytem was ineligible (i.e., served 25 or more permanent residents or had 15 or more active service connections and was not owned by the federal government);
2. the name of the appropriate person within the system who should complete the questionnaire;
3. the current address of the system;
4. the willingness of the system to participate in the study.

Prior to making any calls, each interviewer was thorougnly briefed on the methodology to be followed and given substantial background on the project.

At the end of each day of interviewing, a copy of the survey questionnaire, a letter from the EPA, and a request for participation from the AWWA, NAWC, and CSSE[7] was mailed out to each system contacted that day.

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[a] *These preliminary calls were made between February 18 and March 5, 1976.*

A major problem during this phase involved locating and contacting many of the water systems in the sample which lacked an address and/or telephone number. Every effort was made to contact each system. Beyond calling telephone information, town, city and county government offices were called. In some cases, private individuals who lived in the area were contacted. An effort to contact each system was made at least three times and usually five or more times. Calls were made in the evening to those systems (especially mobile home parks) which consistently did not answer their phones during the day or asked us to call back after 5 p.m.

At the conclusion of the preliminary contact phase, 190 water systems (mostly in the two smallest size categories) could not be contacted and had no remaining alternates in the same size category and region. Questionnaires were mailed to these systems without prior contact.[8] The return rate was 53 percent compared to a 77 percent return rate for those which were contacted.

RECONTACT PHASE

A series of second calls was made to clarify conflicting data, fill in missing information and encourage the return of each questionnaire. Those systems which were having difficulty completing the questionnaire either due to lack of time or lack of information, were given a list of minimum data requirements and asked to complete at least those portions of the questionnaire and return it. Of the 984[b] systems in the final data base, 125 (13 percent) were completed by telephone. Returned questionnaires were coded and, if certain essential information was missing or if inconsistencies were apparent, the water system was called back.

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[7] *American Waterworks Association, National Association of Water Companies, Conference of State Sanitary Engineers.*

[8] *An additional 11 systems were ineligible and had no similar alternates. Therefore, a total of 1,858 systems received questionnaires.*

DATA CODING AND REVIEW

Questionnaire responses were coded onto separate coding sheets as soon as possible after receipt. The coding phase accomplished the dual purpose of preparing the data for keypunching and allowing the coders to identify any obvious inconsistencies or errors in the responses. As indicated above, if key responses were unclear, the water system was recontacted if possible to clarify the problem. All questions which were left blank or responses which could not be clarified or deduced either from other responses, materials included or written comments, were left blank on the coding form and excluded from later statistical tables.

During the course of the coding phase, approximately one hundred and fifty questionnaires were reviewed by TBS because responses were unclear or inconsistent. An effort was made to maintain the integrity of the questionnaires by attempting to recontact the water systems. Reported data was excluded from the database when recontact or other responses on the questionnaire indicated that the item was in error.

Once the coding and keypunching process was completed the data was ready for processing. A tabulation was made to ascertain that the final number of systems included in the database approximated the breakdown required for representativeness by size. During this process, DRC enumerated the water systems which they had attempted to contact. They further categorized the contacted systems into those which had returned completed questionnaires, and those completed questionnaires which could be included in the final database. The table below summarizes the disposition of the sample of systems from the 2,371 names originally drawn from the inventory through the 984 ultimately included in the database.

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[b] *The final number included 780 primary systems and 204 alternates.*

Table III-1

DISPOSITION OF WATER SYSTEMS
DRAWN FROM EPA INVENTORY

Total Sample Drawn from EPA inventory (Including Alternates)	2,371
Total Systems which DRC Attempted to Contact (After Elimination of Obvious Errors and Duplications)	1,732
Systems which DRC Attempted to Contact which did not Receive Questionnaires	474
Systems which Received Questionnaires	1,258
Systems which did not Return Questionnaires	202
Systems who Returned Questionnaires which were not Included in Database	72
Questionnaires Included in Database	984

The various reasons which caused the elimination of systems during the preliminary contact phase through the coding phase appear in Exhibit III-1. In addition, Appendix A includes a brief description of the specific coding practices followed for each question on the survey instrument.

The following section addresses the final phase of the survey process prior to analysis: data processing.

DATA PROCESSING

The data processing phase proved to be the most time-consuming aspect of the survey. TBR had specified a number of statistical calculations (primarily arithmetic means, ratios, and standard deviations) which were to be cross-tabulated according to specified cross-sections of the database.[10] Some 76 different ratios were calculated on approximately 800 cross-sectional tables using CROSSTABS, a statistical package specifically developed for multi-dimensional cross tabulations.

Three significant problem areas arose in the data processing which required several cycles of review and change. The first was the wide range in the magnitude of the numbers. In the financial background information, for example, responses on total assets ranged from $1,600 to almost $2 billion per system. To scale these numbers consistently and present them in terms of ratios repeatedly posed the problem of losing systems whose scaled numbers were too small or creating an interim calculation which was too large for the program and therefore could produce no results. In the second area, the calculation of means required the inclusion or exclusion of responses on a consistent basis throughout the tabulations. This requirement occasionally produced further errors. Thirdly, unusual (or incorrect) responses tended to skew the results in a particular cell or for the overall mean in a size category.[11]

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[10] *For example, mean total assets ÷ million gallons produced per day arrayed by region, system size, and ownership or water source.*

[11] *For example, operating and maintenance expenses per 1,000 gallons in the 5,000-10,000 size category in Region I might show an average of $2.80 while the same result for other regions would be $0.16.*

CROSSTABS did not have the flexibility to address any one of these problems adequately. The lack of flexibility ultimately resulted in transferring the database to another computer system and using a more standard statistical package with some specific program tailoring.[12] The transfer had three major benefits: (1) the range in the size of numbers could be easily handled; (2) medians could be calculated to compare with the means during analysis; and (3) special capabilities allowed the flexibility of including observations which met specific criteria and excluding those which were unusual or did not fit the criteria.

The three most significant drawbacks to the transfer were: (1) the inability to produce results on more than two dimensions at a time; (2) the time lost in repeating many of the statistical analyses; and (3) the expense of repeating computer work. None of the drawbacks seriously affected the analysis of the results which was begun upon completion of the data processing. The materials in other chapters of this document will clarify the specific analytical approaches.

Finally, it should be noted that the "Database for Operating and Financial Characteristics" appears in a document submitted to EPA's Office of Water Supply entitled Support Materials for Community Water Systems Survey Report (11/76).

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[12] *INFORM information management system on the Standard Information Time Sharing System. Special program modifications were made to handle the survey database.*

Exhibit III-1

FINAL RESULTS OF THE 1,732 SYSTEMS WHICH DRC ATTEMPTED TO CONTACT

REGION	I	II	III	IV	V	VI	VII	VIII	IX	X	TOTAL
Could Not Contact/ Locate — Not Mailed	13	33	31	37	16	33	15	33	30	22	264
Could Not Contact Mailed - Not Returned (Reason Unknown)	1	11	4	1	6	4	4	5	13	8	58
Unable to Complete	1	2	1	1	0	1	0	0	1	0	7
Refused to Participate	6	6	18	0	2	3	2	2	6	2	47
Duplicate	3	1	23	5	2	3	3	0	3	0	43
Returned with Insufficient Data	2	0	1	2	1	1	0	1	1	3	11
Not Returned (Reason Unknown)	0	7	0	13	11	27	15	24	0	6	103
No Longer in Operation Does Not Exist	1	5	1	10	7	6	2	0	1	0	33
Not a Community Water System	6	13	5	0	6	3	1	1	10	12	57
Federally Owned	0	0	6	0	0	0	0	0	1	0	7
Seasonal Population Only	7	1	2	1	8	1	0	0	0	4	25
Fewer than 25 Permanent Residents	14	13	12	13	3	4	4	2	8	13	86
Miscellaneous Ineligibles	0	1	1	1	1	0	0	0	0	1	5
Total Not Completed*	72	90	105	96	57	74	45	28	82	69	718
Total Complete	65	84	114	117	120	91	89	52	105	78	1014
Total Contacts	137	184	219	213	178	185	134	141	188	144	1732

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*This category of systems includes all the categories above

CHAPTER FOUR

GENERAL CHARACTERISTICS OF WATER SYSTEMS

The first section of the survey questionnaire was designed to determine some of the basic identifying characteristics of each water system: its location, ownership category, the first year of operation, population served year-round, seasonal population, primary water source, and number of service connections by type. Some of this information was available from the EPA Inventory and was the basis for sample stratification. The information was requested in order to verify or update the Inventory data and to provide a framework for the discussion on operating and financial characteristics. This chapter covers the distribution of water systems by the categories mentioned above; all systems in the sample supplied information in most of these categories.

AGE OF SYSTEMS

The survey confirmed several assumptions regarding the average age of water systems, the ownership structure, and primary source of water. The average age of systems illustrates that the larger the system is, the older it is. The small systems are primarily mobile home parks and housing developments and have consequently been in operation a shorter time. The table below illustrates the average for systems in all size categories and by ownership category.[1]

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[1] *Tables will include, when appropriate, the number of observations upon which the results are based. The number is designated with a parenthesis ().*

Table IV-1
AVERAGE AGE OF WATER SYSTEMS (YEARS) IN 1976

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Average Age (years)									
All Systems	18	24	32	38	47	46	64	81	95
Public	30	35	36	42	48	48	62	77	100
(# obs.)	(8)	(78)	(47)	(69)	(41)	(29)	(43)	(112)	(5)
Private	16	21	20	25	43	22	75	97	72
(# obs.)	(128)	(120)	(16)	(15)	(8)	(2)	(11)	(19)	(1)
Median Age (years)									
All Systems	11	15	26	33	47	38	65	84	94

The rate at which new water systems are formed can also be inferred from the question on the year the responding systems began their operations. As expected, most of the systems which have begun operating since 1970 are in the smaller size categories. In fact, no system larger than those in the 2,500 to 5,000 category began operating after 1970. Therefore, the annual rate of new systems start-up is estimated as follows:

Table IV-2
ANNUAL RATE OF NEW SYSTEM FORMATION
1970-1974

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Rate/Year	5.0%	2.7%	3.2%	0.8%	0.4%	-	-	-	-
# of New Systems	38	26	11	3	1	-	-	-	-

This rate of new system formation reflects an average over the 1970-1974 period. It should be noted that the majority of the activity occurred in the 1970-1971 period before the substantial slow-down in housing starts. Consequently, the proliferation of new systems in the 1975 to 1980 period will depend in part upon the revitalization of the housing industry.

On a regional basis, all regions had some new systems in the period, although the majority of the new water systems were reported in Region IV (the Southeast) and Region X (the Northwest).

OWNERSHIP

The two categories of ownership which were included in the survey database were defined as follows:

Public: owned by local government (municipal, state, district, authority, etc.)

Private: investor-owned or owned by other non-government organization.[a]

The table below illustrates by size category the distribution of systems in the sample according to their ownership structure.

Table IV-3

DISTRIBUTION OF SYSTEMS BY OWNERSHIP
1976

Population Category

	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	>1 million	Total
Public	12	98	77	100	54	39	70	162	10	622
Private	133	137	18	16	9	3	15	30	1	362
TOTAL	145	235	95	116	63	42	85	192	11	984

The pattern of ownership reverses at a system size of about 500 people. Below that level, a majority of the systems are privately-owned: 92 percent of the smallest category and 58 percent of the 100 to 500 category. Above that size, over 80 percent of the systems are publicly owned. While there are some variations among regions, and in the eighth size category, the strong trend linking increasing size and public ownership is amply illustrated in the table below.

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[a] *As described in Chapter III, systems which are federally-owned and operated have been excluded.*

Table IV-4

PUBLICLY-OWNED WATER SYSTEMS (%) BY REGION AND SIZE--1976

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	>1 million
Region I	0	10%	100%	100%	71%	100%	73%	86%	-
Region II	6%	37%	75%	70%	86%	100%	100%	65%	100%
Region III	0	10%	67%	73%	100%	100%	84%	75%	100%
Region IV	0	18%	80%	80%	100%	100%	83%	95%	0
Region V	0	21%	87%	100%	100%	100%	86%	88%	100%
Region VI	27%	63%	67%	82%	67%	100%	100%	100%	100%
Region VII	25%	66%	82%	100%	67%	100%	100%	[illegible]	-
Region VIII	25%	69%	100%	75%	88%	100%	90%	100%	-
Region IX	13%	75%	38%	100%	80%	63%	84%	76%	100%
Region X	4%	47%	86%	100%	100%	100%	100%	83%	-
National Average	8%	41%	81%	86%	86%	93%	82%	84%	91%

In addition to the exclusion of water systems owned and operated by the Federal government, the ownership profile does not include water systems in non-contiguous states or territories.

POPULATION SERVED

A primary determinant of the size and economics of water systems is the number of people they serve. Population served was defined in the survey as the number of permanent (year-round) residents served directly by the water system (excluding transient users and population served through wholesales to other water systems).

The average number of people served by water systems varies relatively little among regions for each size category under 10,000 people, although all average population figures were somewhat higher than expected. The range within each size category was, of course, as extreme as the category itself and therefore, the larger the category, the wider the range. The table below illustrates the average population served by size category and region. Also shown at the bottom of the Table are the median population levels for each system size category. For systems serving fewer than 10,000 people the median and average are virtually identical. For larger system categories, however, the systems are skewed toward the smaller populations in each category, so the medians are somewhat lower than the means.

Table IV-6

AVERAGE POPULATION SERVED
BY REGION AND SIZE--1976

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Region I	55	209	644	1,900	3,475	6,101	33,818	228,071	-
Region II	63	261	760	1,328	3,360	7,089	22,667	281,848	8,452,000ᵃ
Region III	48	248	629	1,675	3,906	6,487	34,000	228,206	1,852,000
Region IV	56	230	707	1,563	3,612	6,843	26,500	244,051	-
Region V	56	215	710	1,680	3,926	6,967	25,429	271,538	2,196,333
Region VI	59	280	673	1,557	3,128	6,378	11,429	237,846	1,381,500
Region VII	64	271	716	1,562	3,541	5,897	15,200	255,667	1,000,000ᵃ
Region VIII	62	258	667	1,438	2,968	6,200	33,500	327,200	-
Region IX	63	198	684	1,338	3,478	6,017	31,786	250,560	2,786,000ᵃ
Region X	58	221	748	1,565	3,277	5,828	22,667	262,333	-
National Average	56	241	693	1,557	3,477	6,310	30,212	253,828	2,386,000
National median	60	225	694	1,800	3,500	6,000	20,000	181,000	1,500,000

ᵃOne system

SEASONAL POPULATION

Water systems were also asked to specify the size, if any, of seasonal population which was served. An identifiable seasonal population was specified by about 18 percent of the systems in the *first six size categories* (25-9,999) and 4 percent in the systems in large categories. While this suggests that a relatively small portion of the water systems serve seasonal populations in addition to the permanent residents, it can represent a significant increase in the demand for water placed on small and medium-sized systems at certain times of the year. As the table below illustrates, the seasonal population is in some instances higher than the permanent population for systems which have such customers.

Table IV-6

AVERAGE SEASONAL POPULATION*--1976

(for systems with seasonal residents)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Average	27	239	204	786	2,060	3,881	36,321	89,805	-
Median	11	75	30	654	1,088	1,230	5,000	10,000	-
(# obs.)	(10)	(33)	(23)	(23)	(11)	(16)	(10)	(10)	-

*Includes only systems reporting seasonal populations

Among the smaller systems with only residential customers, those with seasonal populations have average daily production per capita figures a bit higher than those without additional population. The effect can be most clearly seen in a case such as a small resort community which has 25 permanent residents and 200 seasonal occupants during part of the year.

CUSTOMER CATEGORIES

Average population served is a convenient way to categorize water utilities by size. Population served also provides a consistent unit for expressing volumes of water (i.e., gallons per capita per day) and an alternative manner for discussing consumer charges and other financial characteristics ($ per capita). However, water systems serve a variety of customer types and the mix of customers can be an important determinant of a water system's overall operating and financial profile. The four customer categories identified in the survey questionnaire were residential, commercial/industrial, wholesale and other (agricultural, municipal-town, fire districts, institutional-hospitals, prisons). The categories are discussed below.

RESIDENTIAL CONNECTIONS

Residential customers represent the majority of the total connections for all size categories; they range from 96 percent for the smallest size down to 86 percent for the largest systems. For most small systems, residential service is the only type provided. This fact is not surprising since 48 percent of systems in the 25-100 category are mobile home parks, as are 33 percent of the 100-500 category.

While the residential share of total connections varies little among size categories, a more distinct pattern emerges when examining the number of people per residential connection. Generally, the pattern is more people per connection for the larger systems than for the smaller ones. This number varies from 2.5 for the small systems to 6.2 for the large ones and reflects the higher incidence of multi-family dwellings and other indicators of population density which are characteristic of urbanized areas. The smaller systems operate in more isolated, non-urban localities with fewer multi-family hook-ups. The table below summarizes these characteristics of residential connections for each size category.

Table IV-7

AVERAGE CONNECTIONS AND RESIDENTIAL SHARE--1976

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	≥ 1 million
Average Total Connections	23	94	263	537	1,084	1,946	8,456	62,747	420,371*
(# obs.)	(143)	(230)	(91)	(116)	(63)	(47)	(84)	(191)	(11)
Residential Portion (%)	94%	95%	90%	91%	90%	91%	92%	90%	89%
People per Residential Connection	2.5	2.7	2.9	3.0	3.6	3.5	4.1	4.5	6.2
Median Total Connections	22	79	245	506	1,060	1,770	6,877	47,823	335,000

*Includes New York City. Excluding New York, the average number of connections in the largest size category would be 250,000.

Residential connections are by definition the least varied in characteristics of the connections serviced by water utilities. The service requirements vary within a relatively limited range, and are primarily variable only by the number of individuals at each point of service. Non-residential connections, on the other hand, are characterized by much greater differences in type and demand. The following section will cover the kind and number of non-residential connections; Chapter Five will amplify on the topic as it affects production levels.

NON-RESIDENTIAL CONNECTIONS

The number and type of non-residential connections served by a community water system are the major variables which cause the variation between the production levels of systems within a size category. The differences between size categories are primarily a function of the diversity of commercial and other activity that goes hand-in-hand with increasing population. A brief look at the distribution of non-residential connections by category and size of systems lays the basic context for an examination of the operating characteristics.

A community water system often provides the water used for drinking and other purposes for the commercial and industrial establishments within its service area. On the table below the percentage of systems listed as having no commercial or industrial customers illustrates that most of the systems serving over 500 people also provide at least some service in this category, only 17 percent of the systems in the third category provide no service of this type; and only 2 percent of the systems serving 5,000-10,000 have no commercial/industrial connections.

The percentage of water systems having no wholesale connections is higher; in fact, a majority of the systems serving fewer than 100,000 people have no wholesale customers. Conversely, over 90 percent of the systems serving over 1 million people do sell to wholesale customers.

The "other" customer category includes a variety of non-residential customers, such as specific municipal or fire district hook-ups, institutions, agricultural irrigation, and so on. It is a miscellaneous category for those services connections not easily included in the other major categories. Consequently, the volume of water delivered to such customers varies tremendously depending upon whether the purpose is playground irrigation, a hospital or fire hydrant water supply. The fact that a smaller percentage of the systems in each category reported having no "other" connections than reported having no wholesale connections is probably linked to the lack of specificity in the miscellaneous category. The table below summarizes the average number of non-residential connections for systems which have such connections, as well as the percent of systems reporting no service in each category.

Table IV-8

NON-RESIDENTIAL CONNECTIONS BY SIZE CATEGORY--1976

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Commercial/Industrial Connections									
% of Total*	12%	7.4%	8.4%	8.0%	8.3%	7.6%	7.8%	8.5%	9.4%
Average #	3	7	22	40	88	146	673	6,357	40,023
Systems with None (%)**	79%	54%	17%	13%	7%	2%	1%	2%	0%
Wholesale Connections									
Average #	0	5	1	7	4	2	40	15	24
Systems with None (%)**	100%	98%	94%	89%	86%	78%	71%	38%	9%
Other Connections									
Average #	2	8	7	9	25	15	55	603	3,310
Systems with None (%)	88%	81%	63%	62%	41%	30%	30%	29%	9%

*Percent of total connections for systems which reported commercial industrial/connections.

**Systems which reported "0" connections in the custumer category.

WATER SOURCE

The final identifying characteristic of community water systems is the primary source (ground, surface, or purchased) of the water which they distribute. The water source is of particular importance to the analysis of potential treatment additions which may be required by federal regulations. The treatment practices currently followed are also linked to the existing sources used, and will be discussed in the following chapter.

The results of the survey confirmed the generally accepted premise that the smaller the system is the more likely it is to have ground water as its primary and, generally, only source. Systems serving over 1,000 people are less dependent upon ground water, although in the largest category one system (out of 11) did report ground water as its primary source. Approximately one-quarter or fewer of the systems serving under 1,000 use surface water. It should be noted, however, that those systems which purchase their water may do so from systems which use surface water. There were 121 systems reporting use of purchased water which came from surface sources. Of those, 82 were systems serving over 2,500 people.

The table below presents the distribution of all systems by water source as well as by ownership. The overall pattern does not differ significantly by ownership.

Table IV-9

DISTRIBUTION OF SYSTEMS BY WATER SOURCE (%)--1976

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5K-9,999	10K-99,999	100K-999,999	> 1 million
Total Systems in Survey	145	238	95	116	63	42	85	192	11
Primary Source									
Ground (%)	93	80	71	68	57	64	52	28	9
Surface (%)	1	5	16	17	27	26	31	59	91
Purchased (%)	6	15	13	15	16	10	18	13	-
Private Systems									
Ground (%)	94	80	72	75	67	100	47	40	-
Surface (%)	2	3	11	6	-	-	47	50	100
Purchased (%)	5	17	17	19	33	-	6	10	-
(# obs.)	(133)	(137)	(18)	(16)	(9)	(3*)	(15)	(30)	(1)
Public Systems									
Ground (%)	83	81	68	67	56	62	52	26	10
Surface (%)	-	7	19	19	31	28	21	61	90
Purchased (%)	17	12	13	14	13	10	28	13	-
(# obs.)	(12)	(98)	(77)	(100)	(54)	(39)	(70)	(162)	(10)

---

*The small number of systems responding in this category is insufficient to allow generalization.

The distribution of systems by primary water source from a regional perspective indicates that uniformly across the country most systems use ground water. The ground water share varies from 52 percent to 73 percent of the systems in each region, in addition, there are slightly more systems using ground water in the Midwest, Southwest, and Far West (Regions VI-X) than in the Northeast, Mid Atlantic, and South.

Table IV-10

DISTRIBUTION OF WATER SYSTEMS BY PRIMARY WATER SOURCE AND REGION
1976

REGION	I	II	III	IV	V	VI	VII	VIII	IX	X
Total Systems	95	94	114	117	109	92	89	93	106	76
Ground #	58	49	67	74	65	66	65	62	75	50
%	61%	52%	59%	63%	60%	72%	73%	67%	71%	66%
Surface #	30	26	38	33	24	10	19	22	12	14
%	32%	28%	33%	28%	22%	11%	21%	24%	11%	18%
Purchased #	7	19	9	10	20	16	5	9	18	12
%	7%	20%	8%	9%	18%	17%	6%	10%	17%	16%

*% may not equal due to rounding

The number of systems which supplement their primary source with others is quite small in most size categories. The only exception is size category 8 (100,000 to 1 million). In this case, 37 percent of the surface systems also use ground and/or purchased water and 33 percent of the ground systems use additional sources.

Table IV-11

GROUND AND SURFACE SYSTEMS WHICH SUPPLEMENT THEIR PRIMARY SOURCE--1975

	Population Category									
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million	Total
Ground Systems Also Using:										
- Surface Sources	0	1	0	1	0	0	6	8	1	17
- Purchased Sources	0	1	1	2	2	0	5	10	0	20
Surface Systems Also Using:										
- Ground Sources	1	2	3	1	1	1	7	25	1	42
- Purchased Sources	0	0	0	1	1	1	3	17	2	20

CHAPTER FIVE

OPERATING CHARACTERISTICS OF COMMUNITY WATER SYSTEMS

The production and distribution of water are the two basic operating functions of community water systems. Depending upon the size and complexity of the system, these two major activities include a number of intermediate steps. The processing begins with the raw water collection system and maintenance of raw water reservoirs. It then continues through the conversion of raw water into finished water through a variety of treatment techniques and concludes with the delivery of finished water through pipelines to the customer. In many cases, water testing is conducted at various points in the distribution system.

The survey was designed to capture these operating characteristics only at the broadest level, primarily through the specification of production levels, distribution levels by customer category, and treatment capacities and practices. In addition, operating revenues and expenses were expected to provide an indication of the level of operating complexity for systems in each size category. This chapter covers the operating practices and Chapters Six and Seven will translate these practices into revenues and costs.

It should be pointed out at the outset that "water supplied to your system" was the phrase used in the survey instrument to describe all the water collected during a particular year. The phrase attempted to cover all the definitions of water "production" regardless of the source, or degree of treatment if the water was purchased from other systems. Further, "production" was the term used to cover the annual or daily output of finished water. "Deliveries," on the other hand, were intended to denote the volume of water actually delivered to customers. The difference between the two measures was expected to reflect primarily losses in transmission and distribution, unmetered or unidentified users and so on. Consequently, total production (or water supplied to the system) could be expected to exceed deliveries by at least a small amount.

However, two areas of confusion arose among respondents which made the comparison of production and deliveries difficult, although the breakdown of deliveries by customer class was not affected. First many respondents provided the same figure for both production and deliveries. The first case was most frequent among the smaller systems and often reflects metering at only one point in the system. In other cases the water delivered was unmetered and production and deliveries were estimated from the system's pumping capacity. Second, some included a lower figure for production than for deliveries. The confusion arose over the inclusion of raw water collected from sources and reserved from year to year and not, therefore, interpreted as water "produced" in a single year.

The reporting of results has generally compensated for these discrepancies wherever possible and is described in specific sections or tables.

PRODUCTION

Water production is the basic operating characteristic which permits comparative analysis among systems of different sizes. The information included in this section is used throughout the remainder of the report. Production levels are presented in three forms:

- Average daily production by size category
- Production per capita per day
- Percentage of total production actually delivered to customers

As indicated in the discussion on customer categories, production levels vary depending upon customer mix, both within a size category and across all categories. Daily production in the smallest size category averages about .006 MGD (million gallons per day). The production levels for individual systems in that category, however, range widely--from about one-fifth the average to five times the average (i.e., from .001 to .033 MGD). In the 5,000-10,000 category, the range is from one-eighth to more than double the average level.

The variations reflect differences in population, customer mix, and usage per customer, especially for commercial customers. However, the extremes among the smaller systems are most directly a function of customer mix, while the extremes among larger systems are probably most influenced by the wide spread in population served.

The median level of production tends to be lower than the average in all size categories, indicating that the average reflects the existence of a few systems with very high production levels. The median provides a better indication of the typical production levels while the mean accounts more accurately for the total water production of the sytems in each catagory.

Both the mean (average) and the median levels are shown in the table below, along with the minimum and maximum production levels in system size category.

Table V-1

AVERAGE DAILY PRODUCTION*

1976

(millions of gallons per day)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Mean Daily Production	.008	.025	.075	.200	.480	.921	5.049	46.003	496.660
(# obs.)	(54)	(127)	(78)	(96)	(56)	(63)	(80)	(167)	(11)
Median	.004	.019	.063	.180	.414	.731	3.027	30.948	355.700
Minimum	.001	.001	.011	.020	.073	.117	.368	1.370	117.986
Maximum	.033	.184	.416	1.066	1.426	2.234	24.671	258.526	1,479.246

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*The figures presented in this table are based on the data provided by 730 community water systems. 254 systems were excluded because (1) no production figures were provided (222 systems), (2) production per capita per day fell below 10 (16 systems) or over 600 (16 systems).

Because of the significant differential in production levels among size categories, it can be helpful to examine production on a per capita basis which provides a consistent basis for comparison. The impact of customer mix is more clearly reflected in the per capita figures. In the smallest two categories, which serve almost exclusively residential customers, the numbers are lowest; the values increase as the systems get larger and serve a greater variety and number of non-residential customers. The average ranges from 98 to 214 gallons per person per day. The median is lower, 75 to 185, but maintains the same increasing pattern from small to large systems.

Table V-2

PRODUCTION PER CAPITA PER DAY*
1978
(gallons)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Average per Capita per Day	98	98	109	128	138	147	160	183	214
(# obs.)	(54)	(127)	(78)	(96)	(58)	(47)	(80)	(167)	(10)
Median	75	73	88	106	120	124	128	168	183
Minimum	11	10	16	11	25	23	25	13	118
Maximum	365	469	511	533	317	388	516	591	493

---

*Based upon data provided by 730 systems. Systems producing less than 10, or more than 600 gallons per person per day were excluded.

MAXIMUM DAY PRODUCTION

In addition to average production levels over a year's time, the survey requested information on production patterns at peak periods of demand. Specifically, water systems were asked the maximum volume of water produced on a single day during the year. The original intent was to determine the production capacity of the system. However, "capacity" is a term which is subject to various interpretations. In particular, there was concern regarding the time frame for determination of capacity production. Some systems for example, could produce several times their average day production for very brief periods, others were limited by: storage capacity, primary source constraints, pumping capacity, or treatment capacity. Therefore, the data provided for maximum day production can only be interpreted as that--the highest volume of water demanded and produced at a single point during the year.

The mean ratios of maximum day production to average day production for system size categories fell into three distinct groups. The smallest size (25-100) had a maximum day to average day ratio of over 4; the next six categories (100-10,000) all fell between 1.4 and 2.3, and the two largest sizes reported a mean of 1.6 times as much production on the busiest day as on an average day. This pattern would suggest that larger systems, by necessity, have a much better idea of the extremes in demand of water, and have sized their production capacity and auxiliary storage capacity accordingly. Further, the mix of customers for larger systems may have compensating extremes in demand which help to keep total production requirements relatively stable. Small systems, on the other hand, usually have little if any storage capacity, and few non-residential customers, so that one week of extremely hot weather could cause a level of demand not present at any other time.

The table below illustrates that while the mean ratio for maximum day to average day production varies as suggested above, the medians for all size categories cluster a little bit more tightly in 1.4 to 2.0 range, but maintain the same generally declining pattern between small and large systems.

Table V-3

RATIO OF MAXIMUM DAY TO AVERAGE DAY PRODUCTION

1976

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	>1 million
All Systems -Mean	4.1	2.3	2.2	2.1	1.9	1.7	2.0	1.6	1.6
-Median	2.0	1.7	1.6	2.0	1.7	1.5	1.6	1.5	1.4
(# obs.)	(23)	(62)	(50)	(67)	(41)	(36)	(84)	(158)	(8)

DELIVERIES (SALES)

In spite of the confusion which arose over the relationship between water produced and water delivered, the responses were sufficient to indicate that 83 to 91 percent of the water produced finds its way to customers. However, the number of observations which reported enough information to determine the ratio of deliveries to production was relatively small in some size categories. For those systems included in the tabulation, the median was slightly higher than the average in six out of the nine size categories, over 90 percent of the water produced was delivered. This suggests that most systems in each category lost less than 10 percent of their water; a few had a much higher percentage which caused the average to be lower than the median.

Table V-4

RATIO OF DELIVERIES TO PRODUCTION--1975[a]
(percent)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	>1 million
Deliveries as % of Production (mean)	87	87	87	83	89	83	86	89	91
Median	95	81	86	84	91	90	90	90	92
(# obs.)	(6)	(14)	(13)	(25)	(18)	(23)	(35)	(116)	(4)
% of Total Systems Responding	4	6	14	22	29	58	41	61	36

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[a] These figures are based upon systems which (1) reported both sales and production and both were greater than 10 gallons per person per day and less than 600 gallons per day, and (2) production exceeded sales.

RESIDENTIAL DELIVERIES

Most systems provided data on deliveries by customer type which was consistent with the figure for total deliveries. Given the relative stability of the loss ratio and the differences in deliveries among customer classes, we can infer that the mix of customers is largely responsible for the differences in overall production levels by size category and, as described earlier, also responsible for the wide ranges within size categories. On a per capita basis, total production increases steadily from the smallest to the largest categories (98 to 214 gallons per person per day) because of an increasing number of non-residential customers. These figures can be interpreted more specifically by examining the daily deliveries by customer category.

Residential deliveries on a per capita basis decrease from 100 to 72 gallons per person per day across system size categories. When examined in conjunction with residential deliveries per residential customer (connection) per day, that pattern generally substantiates the earlier observation that there are more people per residential connection in urbanized areas. The table below illustrates the residential deliveries per day for residential customers and per person.

Table V-5

DELIVERIES TO RESIDENTIAL CUSTOMERS*

1976

(gallons per day)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Average Residential Deliveries per Customer per day	411	303	320	295	304	322	451	334	448**
Median	149	158	214	223	240	184	270	287	463
Standard Deviation	913	606	612	236	191	262	330	187	292
(# obs.)	(49)	(97)	(53)	(65)	(36)	(31)	(52)	(125)	(9)
Average Residential Deliveries per Capita	109	108	104	94	79	89	104	79	72
Implied Number of People per Connection	3.7	2.8	3.1	3.1	3.8	3.6	4.3	4.2	6.2

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*Includes systems reporting both deliveries and customers greater than 0.

**Does not include New York City or Cleveland because they did not specify residential deliveries.

NON-RESIDENTIAL DELIVERIES

The residential business of water systems accounts for about 90 percent of their total customers and about 60 percent of total water deliveries. As the following table on non-residential deliveries indicates, the volume of water delivered per non-residential connection is considerably higher than for residential connections. In the case of commercial and industrial customers, the average volume per customer is 1.5 times higher than the residential volume in the smallest category, 6.5 times higher in the fifth size category, and 17.4 times higher in the 100,000 to 1 million category. A large restaurant, for example, consumes much more water per day than a family of four. Other types of commercial and industrial customers, such as laundries or manufacturing plants, use water at even higher rates. This relationship of increasing volume per customer with increasing system size is even more pronounced in the other non-residential categories, particularly in that of wholesale customers.

In general, the pattern of increasing deliveries for non-residential customers is the logical result of water systems serving a larger and more complex mix of customers as the water systems themselves serve larger numbers of customers. What is not reflected in the averages or even the medians, is the tremendous range within size categories. In size five (2,500-5,000), for example, one system reported 20 wholesale customers with a total of 200,000 gallons per year delivered or only 30 gallons per wholesale customer per day. At the same time, another system in that category reported only one wholesale customer but deliveries of 24,000,000 per year or 65,750 gallons per day. In category seven (10,000-100,000), one system serves 999 wholesale customers, and deliveries of 500,000,000 gallons per year, an average of 1,370 per day.

Table V-6

DELIVERIES TO NON-RESIDENTIAL CUSTOMERS*
1976
(gallons per customer per day)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Commercial/ Industrial Customers									
Mean Gallons/Day	614	1,176	1,636	1,348	1,963	1,407	3,046	5,002	5,415
Median Gallons/Day	500	286	456	504	787	872	1,492	2,582	2,493
(# obs.)	(3)	(30)	(42)	(57)	(34)	(29)	(47)	(120)	(8)
Wholesale Customers									
Mean Gallons/Day	-	9,130	2,190	6,040	17,556	102,625	386,193	762,099	20,149,051
Median Gallons/Day	-	13,102	2,192	5,388	2,667	24,657	230,505	348,325	1,027,690
(# obs.)	-	(4)	(2)	(5)	(5)	(7)	(12)	(77)	(8)
Other Customers									
Mean Gallons/Day	380	9,408	1,548	2,401	4,484	7,709	10,074	20,959	8,275
Median Gallons/Day	493	616	1,005	1,370	1,352	4,147	5,009	8,205	7,228
(# obs.)	(3)	(16)	(17)	(26)	(10)	(19)	(26)	(85)	(7)

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*For systems which reported both deliveries and customers greater than 0.

The survey did not explore what particular variations in operating practices are caused by such differences in customer mix and demand. Clearly the impact on the distribution system will be reflected in capital expenditures and operating costs. The variability in those numbers, even on a per thousand gallons basis, can in part be anticipated because of the differences in the production and distribution processes which are characteristic of systems within the same size category and which have been reflected in the discussions above.

TREATMENT PRACTICES AND WATER PRODUCTION BY SOURCE

Treatment practices of community water systems are as varied as the collection and distribution processes and depend not only upon system size but also upon water source, age of system, existence of raw water storage, and pre-treatment processing. Prior to the passage of the *Safe Drinking Water Act*, many systems already provided a variety of treatments such as those to disinfect, add fluoride, control for taste, odor, color and water hardness. Larger systems also provided complex coagulation, sedimentation, filtration, and corrosion control processing.

The survey attempted to document the types of treatments in use before the Interim Primary Drinking Water Regulations by systems in all size categories. This included specifying, at one extreme, those systems which treated none of their water or added only chlorine, and, at the other extreme, those which used each of the many available treatment equipment and techniques. It is noteworthy that 45 percent of the systems serving under 10,000 people provide no treatment to the water which they distribute.[9] Among the sytems in the larger categories (10,000 to 1 million) approximately 9 percent of the systems do not treat the water which they distribute. On the other hand, above 59 percent of tha systems serving over 500 people treat all their water.

The following graph provides an indication of increasing proportion of systems treating 100 percent of their water as the number of people served per system gets larger.

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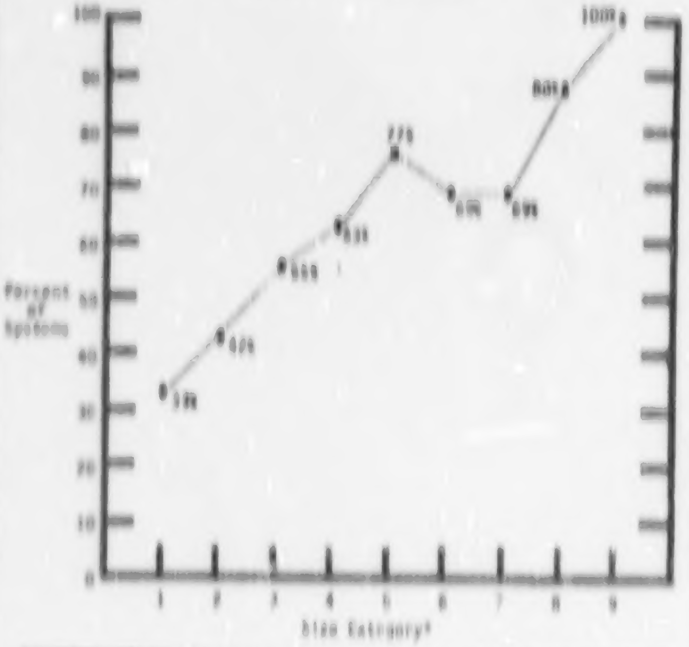
[9] *This does not necessarily mean that none of the water is treated at all. Many of the smaller systems and some larger systems purchase water which may have been treated by the wholesaler.*

The only significant break in the pattern occurs in the size category serving 2,500 to 5,000 people. An examination of the data did not provide any unique characteristic for systems of that size which could account for the aberration. As shown in Table V-7 on 100 percent treatment by primary water source, the same break in the pattern occurs for ground, surface and purchased systems in that size category.[5] It appears that the characteristics of the sample for both size category five and six (5,000-10,000) have combined to indicate an artificially high portion of systems treating all their water. These two size categories have a relatively low number of systems in total; thus, while the number of systems treating all their water is not usually large, the percentage is higher than expected.

Figure V-1

PERCENT OF SYSTEMS BY SIZE WHICH TREAT ALL WATER--1975



1	2	3	4	5	6	7	8	9
25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 Million

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[*] *Systems are defined as "ground" or "surface" depending upon which is the source for over 50 percent of their water.*

Table V-7, mentioned previously, expands upon the graph (Figure V-1) by providing additional detail on the portion of systems by primary water source which treat all their water. Generally, it illustrates that more systems which use surface water as their primary source tend to treat all their water than is the case with ground water systems. The table also indicates that, even when categorized by source, as a system gets larger it increasingly tends to treat all of its water.

The purchased water systems show a much less distinct pattern than surface or ground systems. This is the result of two factors: (1) There are relatively few systems in the sample for which purchased water is a primary source, and (2) Treatment provided by the distributing system is in part a function of the treatment received prior to purchase. These systems were not asked to specify whether the water they purchased had been treated.

Table V-7

PERCENT OF SYSTEMS BY WATER SOURCE
AND SIZE WHICH TREAT ALL WATER*
1978

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	≥1 million
Surface Systems									
% Treating All Water	0	82%	77%	95%	100%	91%	88%	97%	100%
(# obs.)	2	11	17	20	17	11	28	114	10
Ground Systems									
% Treating All Water	33%	43%	50%	65%	78%	70%	68%	80%	100%
(# obs.)	135	189	66	79	56	27	44	24	1
Purchased Systems									
% Treating All Water	29%	27%	0%	19%	33%	0	40%	88%	-
(# obs.)	7	30	11	16	9	4	15	24	-
Total Systems									
% Treating All Water	33%	42%	55%	63%	77%	69%	69%	90%	100%
(# obs.)	144	230	94	115	82	42	86	162	11

*In this table, the number of observations indicates the number of systems in each size category which reported their primary water source; the percentage figure represents the number of systems in each category which treat all the water they distribute.

For those systems which treat all or some of their water, disinfection (usually through chlorination) is by far the most commonly used treatment; 60 percent of all systems responding use disinfection, as do 49 percent of systems under 10,000. The following table illustrates the percent of systems in each size category using various treatments to treat some or all of the water they produce.

Table V-8

PERCENT OF SYSTEMS USING VARIOUS STANDARD TREATMENTS--1975
(percent)

	Population Category									
Treatment	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million	Average for All Systems
Disinfection	30	40	56	61	79	71	79	92	100	60
Coagulation	.7	1	8	10	21	20	32	82	100	20
Sedimentation	1	4	8	11	27	20	33	82	91	22
Filtration	6	9	18	20	31	34	39	89	82	28
Pre Chlorination	1	4	5	13	19	39	32	82	73	22
Flouride Adjustment	.7	2	19	13	24	27	33	54	73	20
Corrosion Control	2	3	12	13	29	41	36	68	91	25
Taste and Odor	0	1	6	6	6	12	10	48	55	13
Aeration	2	2	15	11	15	17	14	25	9	11
Lime Soda	3	2	6	8	10	7	10	22	18	9
Iron Removal	4	6	15	10	16	22	15	20	9	13
Ammoniation	0	.8	0	.9	0	2	4	20	27	5
Activated Alumina	.7	.4	2	4	3	2	5	9	0	3
Ion Exchange	0	1	2	4	5	7	6	3	0	3
Other	2	2	1	.8	2	2	2	5	18	3

TREATMENTS BY SOURCE OF WATER

In general, on a percentage basis, fewer ground water systems use any of the various standard water treatments than do surface water systems.[8] The outstanding exception is disinfection, a procedure used by roughly half the systems in both categories. The next three treatments most frequently mentioned by ground water systems were filtration (15 percent), corrosion control (14 percent) and iron removal (14 percent). The three treatments other than disinfection which were mentioned most often by surface systems were flouride adjustment (51 percent), taste, and odor control (46 percent) and filtration (29 percent).

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[8] *Systems are defined as "ground" or "surface" depending upon which is the source for over 50 percent of their water.*

In addition to the percentages, the actual number of systems reporting each treatment is also listed in the table below. While ground water systems outnumber surface water systems for seven of the fifteen treatments, there are many more ground than surface systems in the sample.[4]

Table V-9

PERCENT OF SYSTEMS USING STANDARD TREATMENTS BY PRIMARY WATER SOURCE--1976

	Surface Systems			Ground Systems*		
Treatment Type		# Systems Responding	# Systems Using Treatment		# Systems Responding	# Systems Using Treatment
Disinfection	52%	(225)	(117)	53%	(627)	(333)
Coagulation	24%	(226)	(53)	5%	(626)	(34)
Sedimentation	23%	(226)	(52)	8%	(625)	(50)
Filtration	29%	(225)	(65)	15%	(623)	(94)
Prechlorination	36%	(225)	(80)	9%	(621)	(59)
Flouride Adj.	51%	(224)	(115)	11%	(623)	(67)
Corrosion Control	18%	(224)	(41)	14%	(622)	(85)
Taste & Odor	46%	(223)	(102)	3%	(622)	(17)
Aeration	17%	(223)	(39)	10%	(622)	(65)
Lime Soda Softening	21%	(223)	(47)	5%	(622)	(33)
Iron Removal	18%	(222)	(39)	14%	(622)	(89)
Ammoniation	16%	(222)	(36)	1%	(622)	(9)
Activated Alumina	10%	(222)	(22)	1%	(622)	(8)
Ion Exchange	2%	(222)	(4)	3%	(622)	(19)
Other	5%	(220)	(10)	2%	(620)	(11)

*Systems which use primarily water from ground sources.

**Almost 3 times as many ground systems responded to the treatment questions in the survey; ground systems represented 64 percent of the total sampled systems, and surface systems accounted for 23 percent.

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[4] *Almost three times as many ground systems responded to the treatment questions in the survey; ground systems represented 64 percent of the total sampled systems; and surface systems accounted for 23 percent.*

However, the table below presents the average daily volume of water produced by source for all systems which reported their production from any combination of the three sources. It illustrates that, in most size categories, surface water production, for those systems which reported it, exceeds ground or purchased production from systems which reported production from those two sources.

Table V-10

AVERAGE DAILY VOLUME OF WATER PRODUCED BY SOURCE*

1976

(millions of gallons per day)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Total Production (mean)	.006	.029	.075	.200	.480	.921	5.049	48.003	496.660
Total Surface Production (mean)	.006	.021	.094	.101	.400	.687	4.023	45.616	371.042
(# obs.)	(2)	(8)	(14)	(15)	(17)	(11)	(32)	(127)	(11)
Total Ground Production (mean)	.006	.026	.067	.196	.476	.900	3.458	23.033	174.311
(# obs.)	(48)	(98)	(88)	(71)	(34)	(29)	(80)	(89)	(2)
Total Purchased Production (mean)	.003	.021	.064	.140	.341	.544	3.114	20.450**	2.500
(# obs.)	(4)	(22)	(13)	(16)	(10)	(3)	(24)	(54)	(3)

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*Table includes all water produced from any source. That is, some systems produce water from more than one source. In order to provide an accurate profile of volume by source, one system may appear in more than one set of observations. Therefore, the total number of observations (surface + ground + purchased) may exceed the number of systems in each size category. The systems included are the 730 in Table V-1 (average daily production).

**There are several systems in this size category which purchase a substantial portion of their water. The three largest are Boston (100 percent), San Diego (90 percent), and San Francisco (85 percent).

Most systems use ground water and only a small portion of systems serving under 10,000 use or reported surface production. Nevertheless, the greater volume of surface water produced (including purchased water from surface sources) and the greater number and proportion of surface systems providing various treatments, substantiates the hypothesis that considerably more surface water currently receives treatments other than disinfection.

CHAPTER SIX

FINANCIAL CHARACTERISTICS: REVENUES & RATES

The preceding discussions have established the operating framework for the chapters on financial characteristics which follow. The survey responses to questions on revenues, operating expenses, balance sheet items and sources of financing were wide-ranging. The variations suggested substantial differences in the financial practices of community water systems across the country. At the same time, water remains generally an inexpensive commodity relative to other essential goods and services. General economic conditions, changing regulations and new operating practices, however, may have an effect on costs, which would necessitate more revenues and changes in water rates. This first chapter on financial characteristics will cover the current profile of revenues and customer rates as indicated by the survey results.

Revenues and rates provide an excellent overall basis for comparison of water system economics among various system sizes, ownership types, and primary water sources. The revenue category serves that purpose well because it combines in a single value each system's overall operating costs and annualized capital costs.

As this and the later chapters will show, the two major factors in determining a water system's economics are: 1) its size, because the data reveal a clear pattern of economies of scale; and 2) local conditions, which show up in the survey data in the form of wide variations in the costs and revenues of otherwise similar water systems. Stated differently, the major conclusions drawn from the survey responses on revenues and rate indicate:

- a pattern of declining mean and median revenue rates with increasing system size, ranging from approximately 80 cents per thousand gallons produced for the smallest systems down to 37 cents for the largest
- wide variation among systems, even of the same size, ownership, and water source, with some systems not charging at all for water, and others charging over $2 per thousand gallons produced.

This chapter discusses three types of water system revenues: first, reported revenues from water operations (including sales, hook-ups, and connection fees); second, budget appropriations from municipalities for the public systems; and third, the implied revenues from other sources indicated by expense rates in excess of revenues from water sales. These three types of revenues are presented below, followed by a section on water system billing rates to customers.

Revenues from Water Operations

The survey questionnaire requested annual data on total revenues from water operations. The last phrase was underlined in the questionnaire to discourage responses which included joint water and sewer revenues or other non-water income such as income from real estate. The form further clarified the question with the parenthetical phrase "including sales, hook-ups, connection fees" and a list of customer categories to indicate that the responses desired should include all forms of water-related revenues from all customer classes. Most systems appear to have understood and answered the question as intended.

The mean annual revenue levels listed in the table below emphasize once again the wide range of system sizes in the sample--from average revenues of $2,200 to $50 million per year. The median revenue levels are listed as well, and are generally slightly lower than the means for two reasons: 1) there are a few systems in each category with unusually high revenues, which affects the mean but not the median; and 2) the overall pattern of small systems generally outnumbering large ones also applies within most of the individual size categories. The most noteworthy difference between mean and median revenue level is undoubtedly at the smallest system size, serving 25 to 100 people, where mean revenues are $2,200 per year and the median level is only $1,100.[1]

Table VI-1

REPORTED ANNUAL REVENUES
FOR SYSTEMS WHICH CHARGE FOR WATER
1976
(thousands of dollars)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Mean Revenues	2.2	7.3	20.1	40.8	88.8	151.1	798.8	6,510.9	50,551.8
Standard Deviation	1.2	6.0	14.8	28.1	63.4	80.9	881.2	5,363.5	35,780.0
Median	1.1	5.6	16.0	35.6	86.3	136.0	542.9	4,647.8	50,344.5
(# obs.)	(50)	(134)	(88)	(108)	(61)	(41)	(83)	(102)	(10)
% Which Do Not Charge	50%	20%	2%	3%	2%	-	-	-	-

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[1] Both the mean and median have been calculated based on systems which do charge directly for water.

A significant difference among system sizes is the percent of systems which do not charge directly for their water at all. As the table in the previous page indicates, the two smallest categories each have a sizeable percentage of systems of this type: 59 percent of the systems serving 25 to 100 people and 28 percent of those serving 100 to 500 people. Those systems appear to fund their water system costs indirectly, either by including their costs in the overall charges for services, as in the case of trailer parks and nursing homes, or by funding the systems directly from the town's budget.

Finally, one must note the wide degree of variation evident in the survey responses within each category as indicated by the large standard deviations relative to the means. As a result, the mean and median figures should be considered as representing the arithmetic "average" and the "typical" systems, respectively, of each size, with wide ranges of individual variations around them. The standard deviations are large in part just because the categories are broad--each one includes systems at one extreme which are two to ten times the size of systems at the other extreme. In addition, as will be evident in the next section, there are still variations even after adjustments are made for different production levels, ownerships, and water sources. Those apparently reflect local conditions which are not fully explained by the responses on the survey questionnaire.

To illustrate the degree of variation in the revenue responses, consider the fifth of the nine categories, that serving 2,500 to 5,000 people. With an average revenue level of $88,600 per year, the sixty-one responses tabulated yielded a standard deviation of $43,400 per year. The statistical implication is that two-thirds of the systems would be expected to report revenues in the broad range of $45,200 to $132,000 (i.e., plus or minus $43,400), and one-third would still be expected to be outside of that range. In fact, of the sixtythe systems in that category which reported revenues, 44 were within that range (72 percent), 8 were below it, and 9 were above it.

REVENUES BY OWNERSHIP TYPE

There appear to be no significant differences between publicly- and privately-owned systems in the levels of revenues collected. As the table below shows, the public and private systems which charge for water reported very similar annual revenue levels. In fact, the mean revenue levels are virtually identical for the four smallest categories, serving up to 2,500 people. For several of the remaining cells, the sample of private systems is too small to make conclusive statements. There is one category, however, (the 100,000 to 1 million population size) for which there are adequate samples of both ownerships and a significant difference in average revenue levels--$9 million per year for private systems and $8 million for public systems.

Table VI-2

PUBLIC VS. PRIVATE SYSTEM REVENUE LEVELS
MEAN ANNUAL REVENUES
1976
(thousands of dollars)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Public Systems:									
Annual Revenues*($)	2.1	7.2	19.7	40.8	83.4	147.8	775.4	8,016.4	53,803.0
% Not Charging	27%	4%	0%	1%	2%	-	-	-	-
(# obs.)	(11)	(79)	(74)	(87)	(53)	(38)	(88)	(182)	(9)
Private Systems:									
Annual Revenues*($)	2.2	7.6	22.1	40.8	119.0	200.0	814.3	9,100.8	21,300.0
% Not Charging	62%	44%	13%	-	-	-	-	-	-
(# obs.)	(111)	(116)	(16)	(14)	(9)	(3)	(14)	(30)	(1)

*For systems which charge for water

The only significant revenue difference between small public and private systems is that more public systems charge for their water. The figures in the table above show that approximately half of the private systems serving fewer than 500 people do not charge directly for water. The public systems, on the other hand, reported only one-fourth of the systems serving 25-100 people and 4 percent of those serving 100-500 people do not chaige directly for water.

REVENUES BY PRIMARY SOURCE OF WATER

Variations in costs, and therefore in revenues, were also expected to be related to the source of water used, with surface water systems exhibiting somewhat higher cost and revenue levels than ground water systems at the same production levels. The survey results, as shown in the table below, seem to bear that out at the larger systems sizes, about 10,000 people per system, but not necessarily for the smaller sizes.

Additionally, systems which rely upon purchased water for the majority of their water appear to have slightly higher revenue levels than either the surface or ground systems for sizes below 10,000 people. For the larger sizes, purchased water systems seem to fall about mid-way between the revenue levels of the surface and ground systems. The next chapter will show that the direct operating and maintenance expenses for purchased water systems are much higher than for surface and ground systems. The fact that the revenue differences are less marked is presumably due to two other factors: 1) all systems of a given size, regardless of source of water, should have the same levels of distribution, administrative, and other system costs; and 2) the purchased water systems ought to have lower fixed investment and capital costs than other systems because they do not produce their own water and in some cases do not treat it either.

Table VI-3

MEAN ANNUAL REVENUE,
BY PRIMARY SOURCE OF WATER*
1976
(thousands of dollars)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	≥ 1 million
Surface	1.6	8.6	20.9	44.0	94.0	192.3	1,152.0	7,321.8	62,036.4
(# obs.)	(2)	(9)	(17)	(10)	(15)	(11)	(25)	(116)	(9)
Ground	2.1	7.2	15.1	37.8	93.0	156.4	645.5	4,407.0	35,000.0
(# obs.)	(43)	(108)	(53)	(71)	(38)	(20)	(44)	(56)	(1)
Purchased	3.0	7.5	23.7	50.8	75.4	171.5	640.0	6,102.5	-
(# obs.)	(8)	(17)	(10)	(16)	(10)	(4)	(16)	(24)	-

*For systems which charge for water

REVENUE RATES PER THOUSAND GALLONS PRODUCED

The calculations were also performed on the basis of revenues per thousand gallons of water produced, in an effort to eliminate differences which simply reflected variations in population served, number of commercial and industrial customers, types of commercial connections served, and the presence or absence of agricultural and wholesale connections. The results of those tabulations are presented in the table below.[1] These rates, it must be pointed out, are not the rates charged to customers which must be based upon deliveries instead of production and which generally vary by customer class. Those figures will be presented later in this chapter.

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[1] *To eliminate distortion of the ratios by erroneous inputs in either production or revenues data, the tabulations were performed only for systems with revenues greater than zero and revenues per thousand gallons produced of $5.50 or less. That upper limit eliminated 34 of 816 questionnaires.*

Table VI-4

REVENUE RATES PER THOUSAND GALLONS PRODUCED*

1975

(cents per thousand gallons produced)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Mean	65.5	85.6	80.5	72.3	71.3	54.1	50.0	43.4	32.2
Standard Deviation	47.7	55.8	46.5	46.6	53.7	28.9	24.6	21.0	11.9
Median	47.9	81.1	60.4	53.2	52.9	48.1	46.2	38.6	26.1
(# obs.)	(23)	(80)	(72)	(88)	(58)	(40)	(80)	(108)	(9)

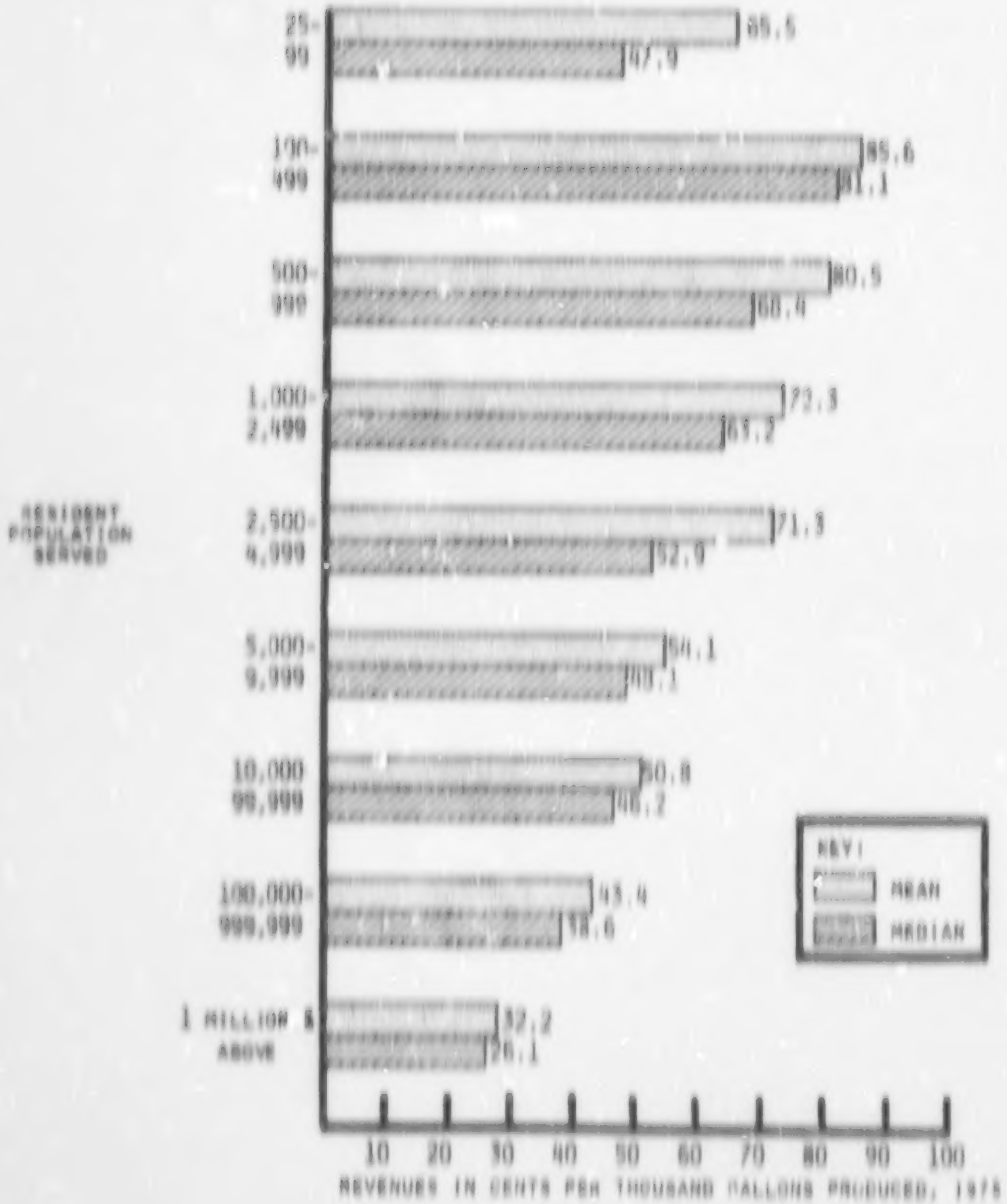
*For systems with revenues and production greater than zero, and revenues per thousand gallons less than $7.50

A pattern emerges from these results which indicates economies of scale in the industry. Except for the very small (below 500 people) and very large systems (over 1 million), the revenue levels are generally in the 40 to 70 cent level range, with declining mean and median rates almost perfectly a function of system size. That pattern is clearly depicted in the graph on the following page.

The revenue levels appear to peak in the second size category, 100 to 500 people, at approximately 80 to 85 cents per thousand gallons produced. From there the revenues trend downward to a low of about 32 cents in the largest category (over 1 million people). The steepness of the decline in revenue levels depends upon whether one focuses on mean rates or medians (the means are higher), but both show the same overall pattern.

Figure VI-1

REVENUES PER THOUSAND GALLONS PRODUCED, ALL CUSTOMERS
(FOR SYSTEMS WHICH DO BILL FOR WATER)

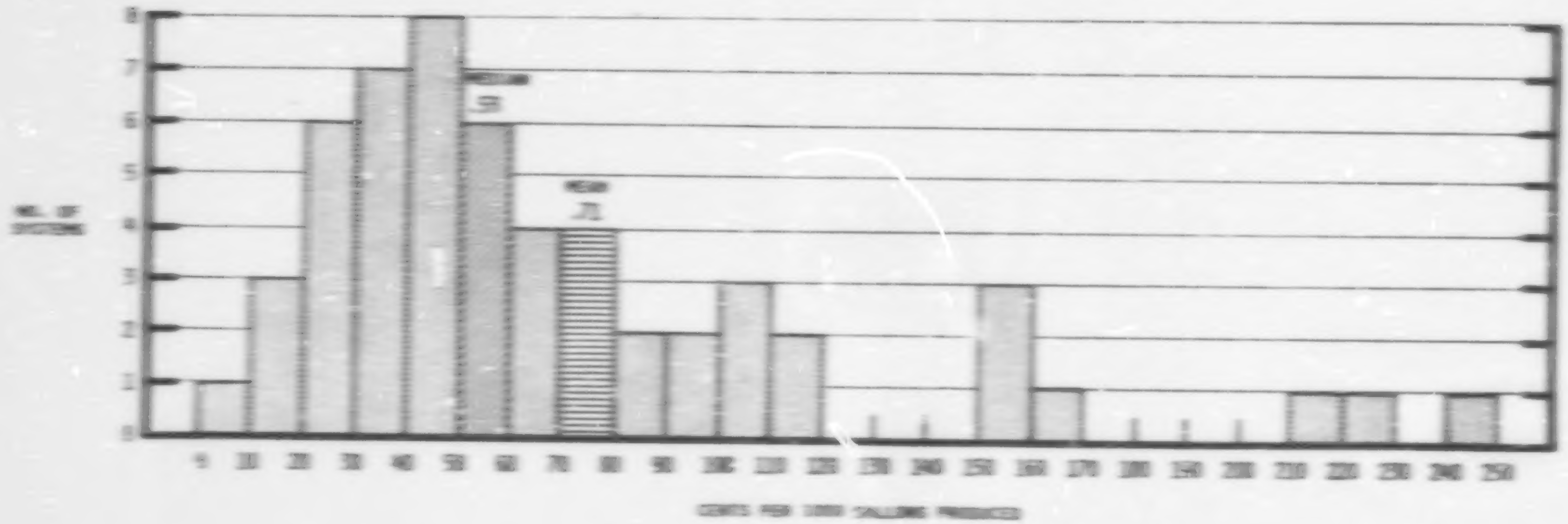


An exception to the pattern of declining rates with increasing system size is indicated in the smallest category, where revenue rates are actually lower than for the next larger size category. The reason appears from the expense data in the next chapter to be the result of donated services or unattributed costs for the systems serving only 25 to 100 people, and to some degree to the difference in treatment levels for the various system sizes.

As with total revenues, the standard deviation indicates a great deal of variation in revenue rates among individual systems in each category. Consider again the 2,500 to 5,000 population category (one of the narrowest categories, with the maximum population size only twice that of the minimum). The frequency of specific revenue levels in that category is plotted below (Figure VI-2) for fifty-five observations in the survey (five did not report production and one was above $2.50 per thousand gallons). From the plot one can readily understand why the standard deviation is so large for most of the sample tabulations--the range of responses is so wide, and skewed to the left, that the means and medians are weak indications of central tendency.

Figure VI-2

DISTRIBUTION OF SURVEY RESPONSES
REVENUES PER THOUSAND GALLONS PRODUCED
FOR SYSTEMS SERVING 2,500 TO 5,000 PEOPLE



NOTE: BASED ON RESPONSES ABOVE 0 AND LESS THAN $2.50 PER THOUSAND GALLONS.

REVENUE RATES BY OWNERSHIP TYPE

There are no significant differences between publicly- and privately-owned systems in total revenue levels; but revenue rates per thousand gallons are lower for public systems. As the table below illustrates, these rates are lower for public systems in all size categories.

The same general pattern of economies of scale (with the exception of the smallest size category) appears for both public and private systems. The only exception to this pattern is the increase in revenue rates between the third and fifth size categories for private systems. This interruption of the pattern may be caused by the more limited number of observations for some categories of privately-owned systems.

Table VI-6

REVENUE RATES BY OWNERSHIP TYPE
PER THOUSAND GALLONS PRODUCED[a]
1976
(cents per thousand gallons)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Public Systems									
Mean	50.5	80.6	72.9	69.4	66.6	63.1	60.8	60.0	50.0
Median	34.2	76.1	63.1	62.8	60.3	60.4	44.9	50.7	50.6
Standard Deviation	60.0	51.9	40.9	42.4	57.2	36.0	26.2	19.2	9.1
(# obs.)	(5)	(59)	(82)	(70)	(47)	(37)	(60)	(150)	(8)
Private Systems									
Mean	89.7	95.6	91.1	97.8	99.1	83.0	82.5	62.5	49.6
Median	56.5	88.9	96.2	71.5	78.9	97.2	66.1	69.9	49.6
Standard Deviation	48.2	67.1	45.6	74.0	57.0	83.7	24.3	21.4	-
(# obs.)	(18)	(30)	(10)	(6)	(8)	(3)	(12)	(30)	(1)

[a] For systems with revenues and production greater than 0, and revenues per thousand gallons less than $7.50.

CUSTOMER RATES--PER THOUSAND GALLONS DELIVERED

The survey included two methods of determining average or typical customer rates. Systems were not asked to report their specific rate structures, however, because each utilizes a different combination of block rates, flat rates, customer use classifications, and metering periods.

The two methods presented here are: 1) a tabulation of residential rates implied by the responses to a question on a typical family's bill for a given level of usage; and 2) a calculation of average rates for each customer class obtained by dividing revenues from that class by water deliveries to it. Each of these methods is presented below.

REPORTED RESIDENTIAL RATES

Systems provided the annual cost of water to a typical family in response to the following question: "Based on your present rate structure, what would a typical residential customer pay per year for 100,000 gallons"?[8] That level of usage is approximately 90 gallons per capita per day for a family of three.

The results of the responses to that question are presented in the table below. One observes from the table that the reported rates are generally higher than rates which can be computed from the revenue levels as presented earlier. One reason for the difference is simply as different denominators: the numbers below are cents per thousand gallons delivered, while the earlier numbers were based upon thousand gallons produced, which are higher. The second, and more significant reason, however, is that the earlier numbers were for all water production of a system, while these refer only to residential customers. The implication that residential customers generally pay a higher rate than other users will be borne out in the next section.

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[8] *An alternative form was also available on the questionnaire for systems to report cost per 100 cubic feet.*

Table VI-6

REPORTED RESIDENTIAL RATES
BASED ON FAMILY USAGE OF 100,000 GALLONS PER YEAR*
1975
(cents per thousand gallons of deliveries)**

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Mean	73.5	89.0	70.5	86.2	93.6	78.2	71.7	66.2	55.6
Standard Deviation	51.1	51.0	90.0	46.6	55.3	48.4	37.3	31.4	18.8
Median	60.0	75.0	65.0	76.0	83.0	60.5	64.0	60.0	52.0
(# obs.)	(51)	(145)	(82)	(67)	(58)	(40)	(76)	(108)	(18)

*Equivalent to approximately 90 gallons per capita per day for a family of three.

**Same numbers also represent dollars per year per family at this level (i.e., 100 thousand gallons x cents per thousand gallons).

The mean rates derived from this question range between 55.6 cents and 93.6 cents per thousand gallons delivered (also $55.6 to $93.6 per year for 100,000 gallons). The lowest rates are those for the largest two size categories. All the other sizes have mean rates of over 70 cents. The median rates are somewhat lower and even more consistent across size categories, ranging only from 52 to 83 cents. Again, the standard deviation indicates that individual system rates vary widely.

COMPUTED RATES BY CUSTOMER CLASS

The second approach to determining average customer rates was to divide the revenues reported from each customer class by the water provided to that class. The questionnaire requested such data for four specific customer groups: residential, commercial and industrial, wholesale, and other. The "other" category was further identified on the form as including "agricultural connections, municipal connections--towns, hospitals, etc.".

Approximately half of the systems which reported total revenues and total deliveries also reported revenues and deliveries for the residential customer class (331 vs. 646). Fewer responded on the other classes, with the tabulation below based upon: 258 responses for commercial and industrial; 92 for wholesale; and 149 for other. The statistical results are summarized in the table below. The results differ somewhat from those reported in the previous section because: 1) a different number of systems responded to the two questions; 2) there is a great deal of variation among systems as has been amply pointed out; and 3) the level of 100,000 gallons per year turns out to be higher than the average family usage.

The general pattern which emerges from computing the rates by customer category can be summarized as follows:

- The largest systems have lower rates for each customer class than do all other system size categories.

- Residential customers generally have the highest rates of all customer classes; in only one size category (2,500-5,000) is there another class which pays more, and there the commercial and industrial customers have a rate which is higher by only one cent per thousand gallons.
- Municipal and institutional customers in the "other" class appear to pay more than commercial and industrial customers in five out of eight categories.
- Finally, wholesale customers pay the lowest average rate in each system size category.

The table below presents the computed rates per thousand gallons for each of the customer classes and size categories.

Table VI-7

COMPUTED RATES PER 1,000 GALLONS DELIVERED*
(cents per thousand gallons)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
					MEAN RATES				
Residential	87.2	95.4	89.9	88.9	86.8	86.8	82.3	63.1	44.9
Commercial/ Industrial	-	71.8	68.4	64.9	87.8	57.0	53.8	40.4	22.2
Wholesale	-	72.8	-	-	82.5	53.8	30.3	31.0	20.5
Other	-	76.5	75.9	69.2	74.0	61.5	44.7	65.0	36.2
Average for All Sales	73.2	89.0	85.1	78.0	73.1	63.5	55.1	47.3	28.3
					MEDIAN RATES				
Residential	88.2	79.4	79.2	50.0	81.6	46.0	53.0	57.0	38.1
Commercial/ Industrial	-	44.2	57.4	56.7	73.0	40.0	47.0	30.7	21.1
Wholesale	-	100.0	-	-	80.6	39.0	20.2	29.3	22.7
Other	-	75.0	66.7	62.0	31.5	22.9	35.2	46.6	35.3
Average for All Sales	88.2	81.6	64.5	65.9	59.2	51.1	40.3	43.2	25.7

*Computed from revenues and deliveries reported by customer class

BUDGET APPROPRIATIONS

Publicly-owned water systems are usually owned and operated as one of the municipal services of a city or town, and their bookkeeping and revenue collections are in some cases quite separate and in other cases very integrated with that of the city or town. Budget appropriations from the municipality's general fund, therefore, can represent two very different types of transactions depending upon the nature of that financial relationship. In some cities and towns the municipality receives the revenues from water sales and transfers money in the form of a budget appropriation to cover the system's expenses. In the other cities, the water system itself receives the revenues from water sales, and either no budget appropriation is received or a small one exists to supplement direct revenues. These cases have been defined for tabulation purposes as: 1) those systems in which the budget appropriation is equal to or greater than reported revenues from water sales; and 2) those in which the budget appropriation is less than the reported revenues from water sales.

The first category, with appropriations equal to water sales or greater, represents 10 percent or less of the public water systems in each size category as shown in the table below. Only 39 systems are in this category, out of 460 publicly-owned water systems which responded to this question.

The other category, with smaller budget appropriations, includes from 10 to 20 percent of the number of public systems in each size category except the smallest (where the number of public systems is too small a sample to be conclusive).

Table VI-8

BUDGET APPROPRIATIONS RECEIVED BY PUBLICLY-OWNED WATER SYSTEMS
1976
(thousands of dollars)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Appropriation Greater Than Water Sales									
% of Public Systems	0%	8%	8%	3%	5%	10%	6%	6%	0%
Mean Annual Level ($)	-	10.7	18.2	82.8	91.5	268.2	554.1	4,742.8	-
(# obs.)	-	(5)	(4)	(2)	(4)	(3)	(3)	(8)	-
Appropriation Less Than Water Sales									
% of Public Systems	0%	18%	21%	19%	13%	10%	20%	10%	13%
Mean Annual Level ($)	-	4.6	5.6	17.7	27.4	130.1	485.7	1,513.4	20,036.9
(# obs.)	-	(11)	(11)	(12)	(8)	(5)	(10)	(15)	(1)

For these systems, the mean budget appropriations level is significant relative to the revenues from water sales--ranging from approximately 25 to 50 percent of the mean revenues figure across the various size categories. The individual systems differ markedly, with many relying heavily on budget appropriations for income (some as high as 80 and 90 percent of water sales), and an equal number reporting appropriations at 30 percent or less. In fact, one out of eight systems reported a figure below 10 percent and one out of fourteen was between 90 and 100 percent.

CHAPTER SEVEN

FINANCIAL CHARACTERISTICS: OPERATING EXPENSES, INTEREST & TAXES

Probably the three most important financial statistics for water systems are: 1) revenues; 2) debt outstanding; and 3) total operating expenses. This chapter presents the survey results on the third, operating expenses of water systems. It also includes the profit and loss (or surplus and deficit) data reported by systems.

This chapter is organized into three sections: first, results on the operating expense categories which include O&M, taxes, and depreciation; second, data on interest expenses; and third, the results on profits or operating surplus.

TOTAL OPERATING EXPENSES

Total operating expenses as used in this report include both fixed and variable costs of operation. These expenses include a system's labor, fuel, electricity, chemicals, and other direct costs of operation. Usually a depreciation or amortization charge is also included, especially for privately-owned systems, as are taxes or payments in lieu of taxes.[1] In fact, for most systems, about the only items not included in total operating expenses are interest charges and profits.

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[1] *In order to obtain as consistent responses as possible, this section of the questionnaire asked for both the total operating expense and the expense in each of several individual categories. In addition, this section differed for the public and private questionnaires, because of differences in tax liabilities and depreciation accounting.*

It is obvious that, with this definition, operating expenses account for the lion's share of a system's revenues, in many cases as high as 85 to 90 percent of the total. Accordingly, it should be no surprise that the patterns exhibited by the operating expense data parallel those already described for revenues.

The total operating expense data is displayed in the table below. Some 698 of the 984 respondents provided usable production and operating expense data.[9] The data reveal a pattern of economies of scale, although as will be seen later, the economies only show up clearly for systems serving over 2,500 people. The smaller systems below that size exhibited mean operating expense rates of approximately 65-80 cents per thousand gallons of water produced. At larger sizes, the mean expense rate drops steadily to approximately 50 cents per thousand gallons for systems serving 2,500 to 10,000 people, 40 cents in the 10,000 to 100,000 population range, and 24 to 30 cents above that.

The median rates for total operating expenses do not vary as widely across system sizes as do the mean rates. The medians are in the 50 to 60 cent range for the four smallest size categories (up to 5,000 people), and then drop steadily to a rate of 18.5 cents per thousand gallons for the largest size. The same conclusion of economies of scale is evident but the curve is not quite as steeply declining.

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[9] *Nineteen other systems provided such data but either misinterpreted the survey questions or reported such deviant information that their inclusion distorts the averages for "typical" systems. One example is an Indian village in the Southwest which would add over $1 to the* *average* *expense rate of the systems serving 25-100 people, because it spends $200 per year with a total production of only 3,000 gallons of water (a cost per thousand gallons of $66!) Accordingly, all systems reporting expense rates per thousand gallons in excess of $3 were excluded from this tabulation.*

Table VII-1

TOTAL OPERATING EXPENSES[a]

1975

(cents per thousand gallons produced)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Mean Total Operating Expense	77.8	64.8	75.8	62.4	57.5	52.8	33.9	31.9	23.5
Standard Deviation	72.1	58.2	56.5	47.3	41.2	39.3	24.1	19.4	9.9
Median	53.3	50.6	67.6	56.2	46.0	36.9	35.8	28.2	18.5
(# obs.)	(48)	(119)	(68)	(86)	(55)	(40)	(80)	(109)	(9)

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[a] For systems with total operating expenses and production greater than zero and operating expenses less than $3.00 per thousand gallons produced.

The variations in total operating expenses for individual systems are substantial. As with revenues, the standard deviation relative to the mean is greatest for the small system sizes, where it is as high as 90 percent of the mean, which indicates a very wide range of responses. The standard deviation declines steadily for larger system sizes, to only 40 percent of the mean rate for systems serving populations of over 1 million. So, not only are operating expense rates higher, but they also range most broadly for the small systems.

The total annual expenses, rather than the expense rates, for the systems are also significant in two respects: first, the annual levels provide a different perspective of the operations of the systems; and second, the wide variations among systems of similar sizes are also evident there. One clear implication of the figures below is that the typical system serving fewer than 1,000 people does not have any full-time employees. In those size categories the median annual operating costs total less than $15,000 per system. Above that size the operating costs rise substantially as plants adopt more formal treatment practices and also require full-time staff in the production and treatment functions. For systems serving over 5,000 people, the average annual operating expenses exceed $100,000.

Table VII-2

ANNUAL TOTAL OPERATING EXPENSE LEVELS*
1975
(thousand dollars per year)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Mean Expenses	2.0	5.5	18.2	36.2	76.2	152.3	622.5	4,889.3	31,248.0
Standard Deviation	4.5	5.9	16.0	25.0	45.4	171.7	565.3	4,297.9	22,434.1
Median	0.9	4.7	13.8	29.3	75.0	120.0	416.4	3,361.2	20,044.0
(# obs.)	(48)	(119)	(88)	(88)	(55)	(40)	(85)	(189)	(9)

*For systems with total operating expenses greater than zero.

The median values for most size categories are very similar to the mean values, with the exception of two extreme categories. For the very smallest size, serving 25 to 100 people, the median is only $900 per year of total operating expense, while the average is $2,000. The obvious implication is that there are a few systems with relatively high expense levels which raises the average. The New York City system, for example, has that effect on the average for the over 1 million category because it is so much larger than the other systems in that category.

As the standard deviations show, each size category has a wide range of expense levels. Much of that is to be expected, however, simply because the categories represent wide ranges of system sizes and production levels. The variations in water treatment practices and local conditions serve to further expand the range of expense levels.

OPERATING EXPENSES BY PRIMARY SOURCE OF WATER

The graph on the following page shows clearly the pattern of economies of scale referred to above. The total operating costs are generally in the 70 cent to $1 per thousand gallon range for the smallest systems and then trend downward consistently as system size increases.

Expectations at the beginning of the project were that surface systems would generally indicate higher operating costs than ground water systems. However, this is not the case in three of the nine size categories. Most notably, for systems serving between 100,000 and 1 million people, the mean operating expense (in cents per thousand gallons) for ground water systems was 10 percent higher than for surface systems.[3] Some size categories which illustrate lower operating costs for ground systems had sample sizes which were too small to be conclusive: of the 26 averages in the table on page VIII-7, four are based on samples of fewer than five systems and four others are based on the samples of five to ten systems.

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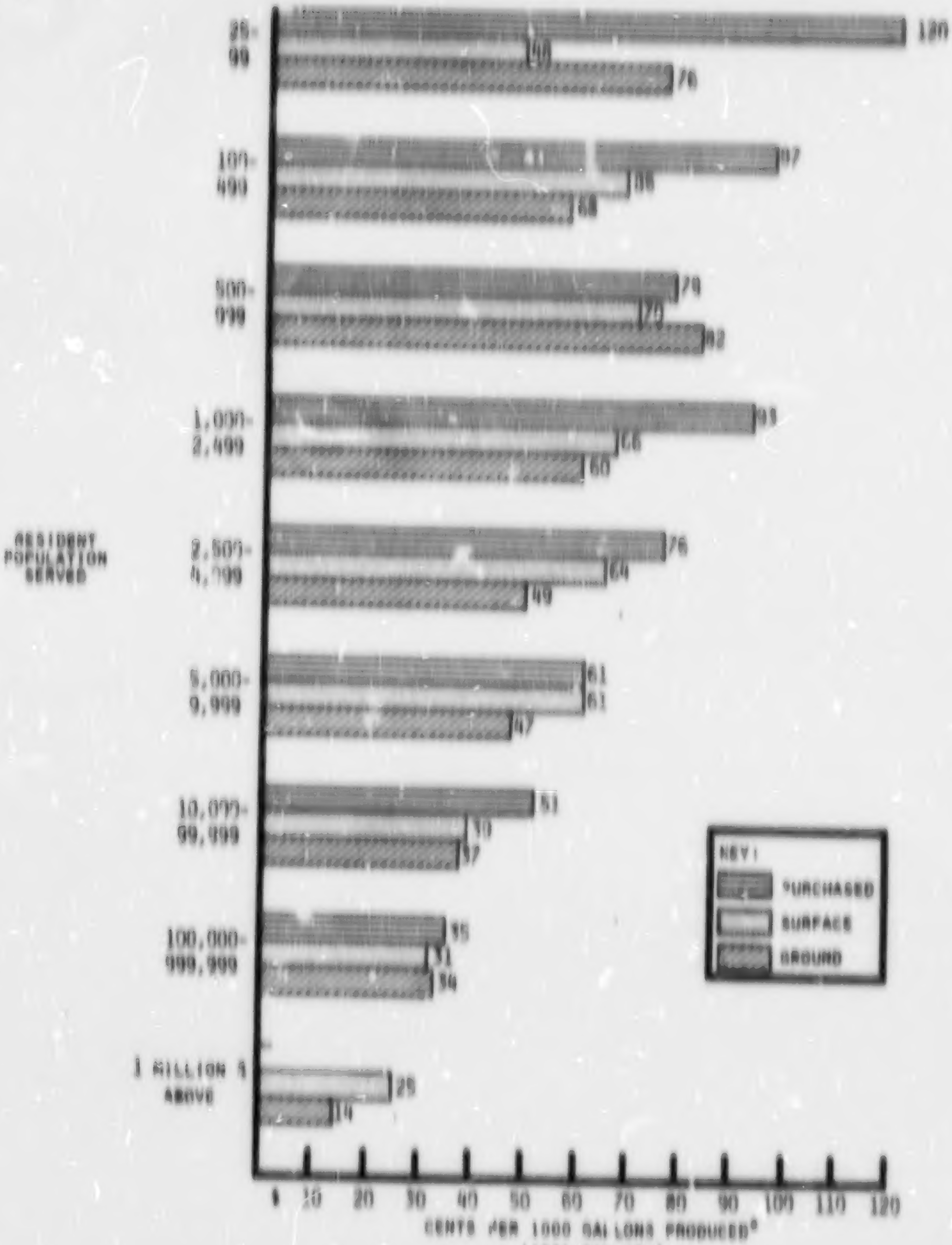
[3] *These ground systems have a lower average daily production than surface systems in the same category; therefore, the ground systems do not seem to obtain the same economies of scale.*

Figure VII-1

TOTAL OPERATING EXPENSES BY PRIMARY SOURCE OF WATER
(MEAN VALUES)



*BASED ON AVERAGE DAILY PRODUCTION LEVELS

In general, the comparative rates for surface and ground water systems show: a) no definitive pattern for systems serving fewer than 1,000 people (based upon relatively small samples of surface systems); b) costs for surface water systems 10 to 30 percent higher than for ground water systems in the 1,000 to 10,000 population range; and c) virtually identical total operating expense rates for both types of larger systems. The rates are shown in the following table.

Table VII-3

OPERATING EXPENSE RATES--
BY PRIMARY SOURCE OF WATER[a]
1975
(cents per thousand gallons produced)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Surface	47.9	86.4	70.1	66.1	63.7	61.1	38.8	30.5	24.7
(# obs.)	(1)	(8)	(13)	(16)	(15)	(11)	(26)	(113)	(8)
Ground	76.1	68.4	81.8	60.3	48.9	47.4	37.1	33.7	16.1
(# obs.)	(42)	(74)	(40)	(63)	(31)	(26)	(42)	(83)	(1)
Purchased	120.2	97.0	77.5	92.6	76.2	61.1	50.6	34.6	-
(# obs.)	(4)	(20)	(8)	(12)	(9)	(6)	(13)	(23)	-

[a] Mean values for systems which reported total operating expenses and production greater than zero and operating expenses less than $3.00 per thousand gallons produced.

The pattern for purchased water system costs is much clearer: they are higher than either of the other sources in almost every instance except for populations of 100,000 to 1 million. At that level purchased water appears to be almost as economical as ground water and about 14 percent more expensive than surface water. For the seven smaller sizes, based upon samples of only 4 to 20 systems in each category, the purchased water system costs ranged from approximately the same as surface or ground water costs for two sizes, to 12 to 50 percent higher for the other five sizes.

OPERATING EXPENSES BY OWNERSHIP

The sample data appear to indicate somewhat higher cost rates for privately-owned water systems than for public ones, although the distribution of systems is such that large samples of both types were only obtained in two size categories. As the following figures show, those two sizes are for populations of 100 to 500 and 100,000 to 1 million. In those two cases the privately-owned sy. ems reported mean cost rates which were 22 percent and 47 percent, respectively, higher than the rates for public systems. The data in the other size categories generally reinforces the conclusion that privately-owned systems have slightly higher total expense rates than publicly-owned systems, although the revenue data in the previous chapter indicates almost no difference by ownership in average annual revenues in the smaller system size categories.

The difference in cost rates below, as shown later in the detailed breakdown of operating expenses, is the result of three primary factors: 1) the absence of tax payments for public systems; 2) the absence of depreciation charges for most public systems; and 3) the availability in small communities of public employees or volunteers whose services for a public water system are either billed generally to the town or donated.

Table VII-4

OPERATING EXPENSE RATES
FOR PUBLIC VS. PRIVATE SYSTEMS*
1975
(cents per thousand gallons produced)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	≥ 1 million
Public:									
Operating Expense Rate	82.0	87.3	70.0	62.3	56.7	52.6	39.0	30.0	22.0
(# obs.)	(7)	(66)	(58)	(76)	(47)	(37)	(68)	(169)	(8)
Private:									
Operating Expense Rate	78.8	82.4	127.1	80.5	61.5	51.9	42.7	44.2	[illegible]
(# obs.)	(40)	(54)	(11)	(11)	(8)	(8)	(12)	(30)	(1)

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*Mean values for systems which reported total operating expenses and production greater than zero and operating expenses less than $3.[illegible]0 per thousand gallons produced.

OPERATING EXPENSE DETAIL

The operating expenses were broken down on the questionnaire into specific categories such as operating and maintenance expenses, taxes, and payments in lieu of taxes. The breakdown differed for publicly-owned and privately-owned systems, because the former generally pay no taxes, and as a rule, record no depreciation expense. There were six detailed items requested on the questionnaire for private systems and three for public.

The accuracy of the responses on the detailed operating expense questions is generally good--over two-thirds of the questionnaires which reported total operating expenses also contained responses on the detailed questions, and the sum of the line item averages is quite close to the mean computed for total operating expenses. As pointed out in the discussion below, the pattern of responses on the "other operating costs" question suggests that there may have been some variation in interpretation of that question, with some systems reporting administrative and miscellaneous expenses under that heading and other systems simply including all their expenses under the broad, first category of "operating and maintenance." Accordingly, these two categories are probably most accurate when combined.

The results for both public and private systems show the major expense category to be direct operating and maintenance expenses, which generally accounts for 60 to 70 percent of the total operating expenses of the system. Because of the different questionnaire formats for public and private water systems, the results for the two types are presented separately below.

PUBLICLY-OWNED SYSTEMS

The reported cost detail for publicly-owned systems is broken into three cost categories: operating and maintenance expenses (O&M); other operating costs; and payments in lieu of taxes. The following table presents the results of the responses to these questions for each of the nine system size categories. The data is presented entirely in terms of cost rates, in cents per thousand gallons of water produced, to facilitate comparisons across size categories and between public and private systems.

At the bottom of the table, for reference, the mean total operating expense rate from Table VII-4 has also been included for reference. The detailed categories sum to a slightly different total because there is so much variation among systems and not all systems provided detailed data.

The sum is within 12 percent of the mean total operating expense rate for all of the sizes, and within 5 percent for four sizes. There appears to be no bias in the differences, for there is neither a pattern by size nor by direction of the variations--for four sizes the sum exceeds the mean total rate while it falls short for five sizes.

The individual line item results are discussed separately for each cost category below.

Table VII-5

OPERATING EXPENSE DETAIL*
PUBLICLY-OWNED SYSTEMS
1976
(cents per thousand gallons produced)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
O&M	92.0	61.1	47.6	46.2	43.8	33.8	25.5	22.3	16.7
(# obs.)	(2)	(45)	(39)	(55)	(27)	(25)	(56)	(143)	(6)
Other Operating Costs	0.0	8.3	11.9	14.3	14.8	14.7	8.0	6.0	7.0
(# obs.)	(0)	(46)	(34)	(49)	(26)	(23)	(51)	(137)	(4)
Payments in Lieu of Taxes	0.0	3.4	6.4	0.4	1.1	1.3	1.1	0.8	0.1
(# obs.)	(5)	(50)	(36)	(48)	(28)	(25)	(45)	(136)	(5)
Total Operating Expense	92.0	72.8	65.9	60.9	59.7	49.8	34.6	29.1	23.8
Vs.									
Reported Total Expense**	(82.0)	(67.9)	(70.0)	(62.3)	(56.7)	(52.6)	(39.0)	(30.0)	(22.0)

*Mean values for systems which reported total operating expenses equal to or greater than zero and less than $3.00 per thousand gallons produced.

**See Table VII-4.

Operating and Maintenance (O&M)

O&M costs include the direct costs of producing water and maintaining the water system. This category includes costs such as labor, fuel, electricity, chemicals, and repairs. There was some variety in the interpretations of these detailed cost categories. For example, some systems may have included administrative costs such as bookkeeping and billing in their O&M costs, while other systems reported that cost as "other operating costs." For that reason, the data may best be used when combined with the "other operating costs" data as suggested earlier.

The mean rates for O&M shown in the preceding table indicate very clear economies of scale for larger water systems. The systems serving fewer than 5,000 people reported O&M rates twice as high (over 40 cents per thousand gallons) as systems serving over 1 million people. The smallest two sizes reported O&M costs approximately three and four times as high as for the largest systems (92 and 61 cents, respectively, versus 20 cents per thousand gallons).

O&M costs account for most of the total operating costs reported by public systems, ranging from 60 to 100 percent for various sizes. In part that is due to the accounting practices of publicly-owned systems, which tend to write off expenses directly and not to depreciate assets. However, the importance of direct O&M expenses would not change appreciably even if those accounting practices changed, as will be seen later in examining the private system data.

Other Operating Costs

This category was listed on the questionnaire directly under the O&M category, but was not defined. It was intended to pick up other expenses remaining after reporting interest and taxes. It was used by various respondents (as revealed in marginal notes on questionnaires and contact with systems) to indicate depreciation expense for some public systems which do record that expense, administrative and accounting expenses, and miscellaneous expenses. Almost as many systems responded to this question as to the O&M question.

One difference, however, was that the response to this question was zero (that is, no such costs) for a significant number of systems. As a result, one way of using the data would be to combine it with the O&M responses to obtain a total of all operating costs except payments in lieu of taxes.

These other operating costs were reported highest for systems in the range serving 500 to 10,000 people--approximately 14 cents per thousand gallons, or 20 to 30 percent of total operating expenses. To the extent that this reflects administrative and accounting costs, it may indicate one diseconomy of scale: that very small systems benefit from donated or shared services for water systems, while slightly larger systems must hire personnel to perform the same functions. At larger system sizes the personnel may be supported by a much larger volume of production, so such cost rates decline to 6 cents per thousand gallons for systems serving 100,000 to 1 million people and to 4 cents for systems serving over 1 million.

Payments in Lieu of Taxes

Publicly-owned water systems are generally extensions of municipal government and not required to pay local, state, or federal taxes. Often, however, payments are made in lieu of taxes, usually to the local government, to take the place of property taxes which would be collected if the water systems were privately-owned. Furthermore, the amount paid by those systems which make such payments is approximately the same as the amount of local taxes paid by private systems.

The figures in Table VII-5 represent the average amount of payments made in lieu of taxes for all publicly-owned systems, including those which do not make such payments. On that overall average basis, the amount is very small, ranging from zero to 4.4 cents per thousand gallons, and is below 1.3 cents for six of the nine size categories. Interestingly, the highest rates are for small systems, serving 100 to 1,000 people.

The data are also presented below in terms of the percentage of reporting systems which do make payments in lieu of taxes, and what that average amount is. The percentage of publicly-owned systems which make such payments is zero for the smallest category; it is around 10 percent of the systems serving 100 to 2,500 people, and climbs gradually up to 40 percent of the systems serving 100,000 and more people.

The average amount paid by the systems which make payments in lieu of taxes is quite high for the smaller systems--28 and 53 cents per thousand gallons, based on small samples of only six systems serving 100-500 people in the first case and three systems serving 500-1,000 people in the second. At larger system sizes the amount paid drops to approximately 6 cents per thousand gallons and then gradually down to under half a cent for systems serving over 1 million people.

Table VII-6

TAX EXPENSE FOR PUBLIC SYSTEMS, 1975
FOR SYSTEMS WHICH DO PAY TAXES

Size (population served)	Percent Making Payments in Lieu of Taxes	Average Amount Paid (cents per thousand gallons)
25-99	0%	-
100-499	12%	28.3¢
500-999	8%	53.0
1,000-2,499	7%	6.4
2,500-4,999	18%	6.1
5,000-9,999	20%	6.5
10,000-99,999	31%	3.6
100,000-999,999	39%	2.1
1 million and over	40%	0.3

PRIVATELY-OWNED SYSTEMS

More cost categories were used for the breakdown of operating expenses for privately-owned systems than for public systems in order to identify depreciation and federal, state, and local tax charges. In all, six cost items were requested on the questionnaire.

The survey results in this area are presented in the table below, in a format similar to that used above for public systems data. The table presents cost rates in cents per thousand gallons of water produced, and includes the mean overall operating expense row at the bottom from Table VII-4. Again, the detailed categories do not sum exactly to the overall figure due to the variation in response rates on the different questions. The sum of the detailed costs is within 10 percent of the mean total operating expense rate for all but one size category.

Table VII-7

OPERATING EXPENSE DETAIL*
PRIVATELY-OWNED SYSTEMS
1976
(cents per thousand gallons produced)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
O&M	54.7	49.7	75.4	47.3	38.0	26.3	31.7	27.0	10.1
(# obs.)	(29)	(29)	(7)	(8)	(5)	(3)	(10)	(28)	(1)
Depreciation	22.0	10.1	27.7	9.5	5.4	8.1	5.0	4.1	4.5
(# obs.)	(18)	(25)	(7)	(3)	(6)	(3)	(10)	(29)	(1)
Federal Taxes	0.0	1.5	4.0	0.4	0.0	3.1	4.8	2.2	6.7
(# obs.)	(23)	(26)	(6)	(3)	(4)	(3)	(9)	(26)	(1)
State Taxes	1.5	0.8	1.5	0.0	0.8	1.2	2.1	0.9	0.5
(# obs.)	(23)	(26)	(6)	(13)	(4)	(3)	(9)	(23)	(1)
Local Taxes	0.6	3.2	5.8	1.8	6.1	8.5	5.5	3.2	8.8
(# obs.)	(23)	(28)	(7)	(3)	(5)	(3)	(8)	(27)	(1)
Other Operating Costs	6.7	5.9	21.9	29.5	1.2	2.1	0.4	0.6	7.0
(# obs.)	(15)	(20)	(6)	(5)	(4)	(2)	(9)	(20)	(1)
Total Operating Expense	85.5	78.2	136.3	86.7	46.5	52.6	60.2	36.6	38.5
vs.									
Reported Total Operating Expense**	(78.6)	(86.4)	(127.1)	(86.5)	(41.5)	(51.9)	(46.7)	(44.2)	(15.7)

*Mean ratios for systems which reported total operating expenses equal to or greater than zero and less than $3.00 per thousand gallons produced.

**See Table VII-4.

The data in the table are discussed separately below for each detailed cost category.

Operating and Maintenance (O&M)

As with the public systems, O&M costs for private systems consist of the direct costs of running a water system: labor costs, fuel, electricity, chemicals, and repairs. Administrative and billing costs may occasionally have been included in this category, so the costs may be most accurate when combined with the "other" operating costs.

These O&M cost rates reveal the operating economies of scale which exist in privately-owned water systems. As with public systems, the very large systems serving over 100,000 people reported costs of around 20 cents per thousand gallons, while systems below 5,000 people reported costs of 40 cents and above.

It appears from these results and from the public system data presented earlier that O&M costs tend to peak at about 60 cents per thousand gallons even for small systems, with occasional individual system costs running up as high as $1.50 and more only in unusual situations. The only instances in which mean O&M rates exceed 61.1 cents for either ownership are two cases with small samples, one with seven systems and another with six.

Depreciation

Depreciation is an annual amortization of plant and equipment, and is intended to approximate the rate at which the useful life of such assets is used. Most private systems responded to the depreciation question. For the two smallest size categories, half of the systems responding entered zero as their charge; otherwise, most systems reported a non-zero cost. The mean depreciation rate for all systems, including those with zero, is listed in Table VII-7.

The depreciation charge per thousand gallons is highest for the small system sizes, serving 25 to 1,000 people, reflecting the economies of scale in plant and equipment in the water utility industry. For those small system sizes the rate is 18 to 27 cents per thousand gallons, while it is less than 10 cents for all larger size categories. The depreciation cost curve flattens out for the largest sizes at 4 to 5 cents per thousand gallons.

The depreciation expense rate shown for systems serving 2,500 to 5,000 people may be low by a few cents per thousand gallons. That is indicated by the pattern of expenses for the other sizes and the fact that the sum of the detailed costs for this size category is significantly lower than the mean overall operating expense rate at the bottom of the table.

Taxes--Federal, State, and Local

Investor-owned water systems are subject to federal and state income taxes, like other business corporations. Many of the smaller systems, however, reported no income and pay no taxes. Those systems apparently operate at (or below) a break-even level, presumably charging just enough to cover expenses and provide a service, in an area where the stockholders are also the customers of the water system.

Local taxes, which are generally property taxes, are paid by a much larger share of the private systems than of the publicly-owned systems, though still not by all of them.

The average tax payments, including systems which do and those which do not pay such taxes, are presented in Table VII-7 above. Those figures show federal taxes ranging from zero to 4.8 cents per thousand gallons, with five sizes averaging less than 2 cents and four averaging more. State taxes are close to the same level, ranging from zero to 3.5 cents per thousand gallons, with seven sizes averaging below 2 cents and only two above that. Local taxes, however, are the highest tax cost, at 0.5 to 8.6 cents per thousand gallons, with six sizes above the 2 cent level.

The data are also presented below for the systems which reported non-zero tax payments. The data are based upon relatively small samples, of 20 to 25 observations for the size category 100,000 to 1 million people, and usually only four to nine observations in the other sizes. Nevertheless, the general patterns are obvious: proportionately more systems pay taxes in the larger sizes, and in all sizes the systems pay more in local taxes than in federal or state taxes.

Table VII-8

TAX EXPENSE FOR PRIVATE SYSTEMS, 1976
FOR SYSTEMS WHICH DO PAY TAXES

	Federal Taxes		State Taxes		Local Taxes	
Size (population served)	%*	¢/1,000 gals.	%*	¢/1,000 gals.	%*	¢/1,000 gals.
25-99	0%	0	17%	9.6¢	9%	6.9¢
100-499	10%	7.8¢	15%	5.2	41%	7.7
500-999	67%	6.0	67%	5.3	67%	10.2
1,000-2,499	33%	0.6	0%	0	33%	4.8
2,500-4,999	0%	0	50%	1.6	60%	6.8
5,000-9,999	67%	4.7	67%	1.8	33%	25.8
10,000-99,999	50%	5.4	100%	2.1	80%	5.6
100,000-999,999	40%	2.6	87%	1.0	93%	3.5
1 million and over	100%	0.6	100%	0.5	100%	0.5

*Percent of reporting systems which do pay such taxes

Other Operating Costs

This category generally includes administrative and accounting costs and miscellaneous expenses of water systems. There is not a clear definition of this category on the questionnaire, so, as mentioned earlier, the costs should be viewed in a general context and may best be used in combination with operating and maintenance costs.

The pattern of other operating costs for private systems is similar to that for public systems, with the highest cost rates reported not for the smallest systems but for systems serving over 500 people. For the smallest systems, both public and private systems probably use donated or shared services for bookkeeping and other administrative tasks. In fact, it may be recalled that a significant number of the smaller private systems do not even bill for water. At system sizes above 500 people, however, the administrative workload becomes great enough that it results in a formal cost to the water system.

The other operating cost rate averaged less than 6 cents per thousand gallons for all but two size categories. For those two sizes, systems serving 500 to 1,000 and 1,000 to 2,500 people, it averaged 22 to 30 cents per thousand gallons based on samples of only 4 and 5 observations respectively.

INTEREST EXPENSE--ALL SYSTEMS

Since water systems are relatively capital intensive, interest expenses constitute a significant expense for them. In fact, as the following figures indicate, interest costs generally range from five to ten cents per thousand gallons.

or about 20 percent of total revenues. Even the capital intensive electric utility industry generally only has interest costs of approximately 10 percent of total revenues.

The following table lists the average interest expenses on the basis of costs per thousand gallons of water produced (for comparison across size categories and for reference to the data on other cost categories). The interest expense rates for all systems, that is both public and private, are highest for the systems serving 100 to 500 people (22.8 cents per thousand gallons), and then decline for larger system sizes. They are in the ten cent range for systems serving 500 to 10,000 people, and take another step down to the five cent range for very large systems serving over 100,000 people.

The lowest average interest expense rate is that shown for the very small systems serving 25 to 100 people. The average rate shown, however, reflects the fact that most of these small systems pay no interest at all. The overall mean shown is actually the average of 31 systems which pay no interest and 4 systems which pay an average of 20.2 cents per thousand gallons of water produced. As the next chapter will show, the majority of these small systems have no debt outstanding.

Table VII-8

INTEREST EXPENSE--ALL SYSTEMS, 1976[a]
(cents per thousand gallons produced)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	>1 million
All Systems	2.3	22.8	11.7	10.0	10.7	9.8	7.3	5.6	5.1
(# obs.)	(35)	(95)	(34)	(52)	(47)	(31)	(84)	(172)	(9)
Public	0.0	24.5	12.0	7.8	9.3	10.5	6.6	5.2	4.9
(# obs.)	(6)	(58)	(27)	(44)	(40)	(29)	(67)	(147)	(8)
Private	2.8	11.4	11.2	20.6	10.9	0.1	11.2	8.1	5.7
(# obs.)	(29)	(37)	(7)	(8)	(7)	(2)	(17)	(25)	(1)

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[a] Mean values for systems which reported interest expense equal to or greater than zero and production greater than zero.

A comparison of interest expense rates for the public and private systems does not reveal a significant difference between the ownership types except at the largest system sizes, over 10,000 people. At smaller sizes than that the differences are random, with public systems sometimes higher and sometimes lower, and based upon relatively small samples in one or the other ownership category. For the categories of 10,000 people and above the data seems to point to higher interest expense rates for privately-owned systems than for public ones. That difference due to ownership is approximately 2 to 3 cents per thousand gallons for the two largest size categories and presumably stems from the ability of the public systems to secure lower interest rates by offering tax-exempt municipal bonds.

Embedded interest rates have also been computed from the annual interest expenses and the long-term debt balances reported on each questionnaire. The results of that computation for all questionnaires which contained both responses are shown in the following table.

Both the mean and median embedded interest rates are very constant across all system size categories, with only one significant deviation which is a drop of about one-half a percentage point for the systems serving over 1 million people. With that exception at 4.6 percent, the mean rates range between 5.1 and 6.2 percent. The median rates are slightly lower, reflecting higher interest rates on recent debt issues. They range from 4.8 to 5.4 percent for all but the largest category, which showed a median rate of 4.4 percent.

On the basis of ownership, the embedded interest rate is consistently lower for publicly-owned systems in all size categories. It should again be noted from the table below that the number of observations for privately-owned systems is quite small in most size categories. For publicly-owned systems serving populations of 5,000 to over 1 million, the interest rate declines steadily from 6 to 4.4 percent of long-term debt. Smaller systems indicate rates between zero (no debt) to 5.5 percent.

Table VII-10

EMBEDDED INTEREST RATES*
1975
(percent)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	≥1 million
All Systems									
Mean	5.8	5.1	5.4	6.2	5.7	6.5	5.8	5.4	4.6
Median	4.9	4.8	5.0	5.0	5.2	5.4	4.9	4.8	4.4
(# obs.)	(6)	(33)	(28)	(40)	(26)	(17)	(33)	(132)	(7)
Public Systems									
Mean	○	4.5	5.5	6.0	5.4	6.2	5.3	5.0	4.4
(# obs.)	○	(22)	(26)	(36)	(21)	(16)	(28)	(108)	(6)
Private Systems									
Mean	5.8	6.4	4.5	7.3	6.9	10.2	8.5	7.0	5.7
(# obs.)	(6)	(11)	(2)	(4)	(5)	(1)	(5)	(24)	(1)

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*Computed as interest expense divided by long-term debt for systems with interest expense and long-term debt greater than zero and embedded interest rate between 3.0 and 20.0 percent.

SURPLUS OR DEFICIT AND PROFIT OR LOSS

Water systems were asked to report their profit positions in 1974-1975; the response was expected to be the difference between the revenues and expenses discussed earlier. However, an examination of the reported responses compared to computed profit or losses indicated that a number of factors produced responses that do not simply reflect the difference between revenues and expenses. These factors are discussed below because they have a bearing on the interpretation of the tables which follow.

Apparent from the responses is the fact that public and privates systems have slightly different concepts of "profit" and "loss." The differences are the result of public and private systems' treatment of debt service costs and depreciation. Private systems use an accrual form of income accounting. That is, they subtract depreciation and interest expenses but not principal repayment of debt. Publicly-owned systems, on the other hand, generally use a budgeting approach related to cash outlays for items other than capital. While there is no depreciation account, interest and principal repayment are subtracted.

These different accounting methods offset each other to a degree. However, principal repayment is generally lower than depreciation. Consequently, private systems, with slightly higher operatng expenses may need to set their rates slightly above public systems in order to maintain the same apparent level of profit or surplus.

The function of profits also play a part in rates. For private systems, above the smallest category, profits are an essential requirement for staying in business. Publicly-owned systems need to be self-sustaining in the long-run, but in the short run, their surplus or deficit position may be more closely tied to the annual municipal budget and related political considerations. Consequently, a single year's surplus or deficit may not be indicative of a public systems' actual revenues and expenses.

The tables which follow reflect the level of profit/loss or surplus/deficit which are reported of the water systems financial statements. In those cases where a computed result would be different from the reported number, the contributing factors described above. In addition, particularly for smaller systems, the difference is also due to the fact that there may been other income or extraordinary expenses not included in the categories on the questionnaires. Therefore, these systems included their profit/loss or surplus/deficit figures without all the income (generally public systems) or expenses (private systems) necessary to recreate the reported figure.

REPORTED RESULTS

The distribution of systems reporting surpluses and deficits is shown in the following table. It is interesting to note that the percentage of public systems reporting a surplus is consistently in the 70 to 80 percent range for almost all system sizes. A small number of the other 20 to 30 percent may simply have delayed a rate increase too long or experienced an unusual increase in expenditures (1975 was, by the way, a year of significant increases in electricity and fuel costs). Most of the 20 to 30 percent reporting a deficit, however, may have planned for it. Many large public systems, in particular, have indicated a political reluctance to increase rates every year, so they compensate by increasing them more steeply every few years, and operating at a surplus for two or three years and then at an offsetting deficit for a year or two.

Table VII-11

SURPLUS OR DEFICIT--1975
(number of systems reporting)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Public Systems									
Surplus	4	43	33	49	30	23	42	130	3
Deficit	1	11	13	18	12	7	16	26	2
% with Surplus	80%	80%	72%	73%	71%	77%	72%	83%	60%
Private Systems									
Profit	9	26	5	4	7	2	6	26	1
Loss	7	12	3	3	-	-	-	-	-
% with Profit	56%	68%	63%	57%	100%	100%	100%	100%	100%

The private systems, in contrast, reported no deficits for systems serving over 2,500 people. Presumably, they do not have the same flexibility--or political pressures--to use surplus and deficit operations in order to increase rates less frequently. At the smaller sizes, over half of the private systems reported deficits, although the sample size is very small.

Reported surpluses and deficits for public and private systems are shown in the following table in cents per thousand gallons. Public surpluses generally declined as system size increased and ranged from over 50 cents per thousand gallons in the smallest size to 3 cents in the largest size, with six sizes having surpluses of less than 10 cents. The median rates for public systems did not vary nearly as widely across system sizes as did the mean rates; the medians ranged from 19.4 cents to 4.0 cents. Public deficits exhibited similar characteristics, generally declining with larger systems and having less widely dispersed median values.

Private system profits ranged from over 90 cents per thousand gallons in the smallest size to less than 2 cents; five systems had profits greater than 10 cents per thousand gallons; however, the sample size was small with the median number of observations being only five. The range of median rate for the private systems was equally large and for the most part the values of the medians closely followed those of the means. Private system deficits were sizable although these deficits only existed in systems serving fewer than 2,500 people.

Table VII:12

REPORTED SURPLUS OR DEFICIT--1976*
(cents per thousand gallons produced)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	≥1 million
PUBLIC SYSTEMS									
With Surplus									
Mean	51.4	46.0	27.6	14.3	10.0	18.9	12.3	7.8	3.4
Median	10.2	19.4	17.3	7.4	6.5	10.6	7.3	5.1	6.6
(# obs.)	(4)	(36)	(31)	(41)	(27)	(23)	(41)	(100)	(3)
With Deficit									
Mean	-	20.6	70.8	15.5	10.3	62.0	7.6	2.5	0.2
Median	-	10.9	18.0	10.6	4.0	4.4	0.8	1.1	0.0
(# obs.)	(0)	(10)	(11)	(17)	(12)	(7)	(16)	(24)	(2)
PRIVATE SYSTEMS									
With Profits									
Mean	93.2	47.6	15.5	55.7	10.3	1.6	8.7	8.6	7.8
Median	93.7	30.3	10.1	55.7	11.6	1.6	6.3	6.9	7.8
(# obs.)	(4)	(17)	(6)	(7)	(6)	(2)	(7)	(26)	(1)
With Loss									
Mean	61.5	23.8	75.4	7.4	-	-	-	-	-
Median	36.2	13.2	90.8	6.3	-	-	-	-	-
(# obs.)	(6)	(9)	(3)	(3)	(0)	(0)	(0)	(0)	(0)

*For systems reporting surplus or deficit and production greater than zero and surplus or deficit not greater than $5.00 per thousand gallons produced.

CHAPTER EIGHT

FINANCIAL CHARACTERISTICS: BALANCE SHEET ACCOUNTS AND CAPITAL EXPENDITURES

This chapter focuses upon the survey data related to the assets and liabilities of water systems. The long-term financial position is discussed in terms of capital investments and sources of financing as opposed to the annual costs and revenues reported in the two previous chapters. This chapter also includes data on the systems' reported capital expenditures over the 1970-1975 period, including the amount, purpose, and financing of those capital projects.

Water systems are among the most capital intensive operations in the country. The reported figures show that approximately $10 of assets are required to generate one dollar of annual revenues. In other terms, the average water system investment to serve a family of three ranges from approximately $300 for the largest systems up to $1,600 for a small system serving only 100 to 500 people. This chapter presents the details of that capital profile in three sections below: assets; capital and liabilities; and capital expenditures, 1970-1975.

ASSETS

The survey questionnaire requested information on seven categories of assets; the categories were primarily focused on long-term assets in the form of production and treatment facilities and the water distribution system.

The same information was requested from both public and private systems with the expectation that plant costs might differ as a function of size and terrain of service area, population density, and water source, but not significantly by ownership.

The asset questions began with a line for total assets, followed by six lines for the detail within that total. The first four of those detailed lines were all under the heading "plant and equipment" and were: production-treatment plant(s); distribution systems; all other plant and equipment; and the total accumulated depreciation or sinking fund for replacement (if any). The other two detailed lines were: current assets; and "other assets not included in the above categories."

Most systems responded to the first question: 506 questionnaires yielded total assets data which appeared accurate. Fewer systems responded on the detailed questions, and fewer still completed the full breakdown of assets into the six detailed categories. Only 286 questionnaires were completed to that extent.

There were also at least two problems of interpretation. One which was easily detected and corrected was that some systems entered the present amount of their total assets under "current assets" rather than showing only their cash, receivables, and other short-term assets. The other problem was one of inconsistency among responses to the total assets question which was not as easy to perceive. The total assets question requested data on the original cost of each water system's assets in order to obtain consistent accounting among publicly- and privately-owned systems (i.e., not original value in some cases and value net of depreciation in other cases). It appears that most systems correctly understood that to mean either their original system cost plus additions and other assets, or their present total assets excluding depreciation, if any. Some number of systems, however, provided only their present total assets, net of whatever depreciation they carry, and some others entered only the total value of their plant and equipment.

The misinterpretations were corrected to the extent that they were evident and could be adjusted from the data provided. Unfortunately, these misinterpretations were not always evident or detectable since approximately half of the questionnaires which reported total assets did not provide a breakdown of the asset sub-categories. However, evaluation of the detailed breakdown of assets where it was provide showed them to be much more accurate and reliable. Accordingly, two decisions were made: first to present the reported total assets data in a single table, for reference, and secondly, to rely on a buildup of the individual categories for the analysis and comparisons which are presented in the remainder of the chapter.

The results for reported total assets are shown in the table below. The mean asset levels range from only $17,000 for the smallest systems to $423 million for the largest ones. The median levels are somewhat lower, ranging from only $10,000 to $373 million. The large size of the standard deviations relative to the means is again an indication of a wide variation in individual system responses. For example, within the range of responses which appear to be accurate, the smallest system category included total asset values as low as $1,000 and as high as $50,000.[1]

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[1] *The tabulations on assets were based upon responses for systems reporting total assets to average daily production ratios of from $0.25 to $20.00, in order to exclude obvious data errors. Even within that range there may still be errors and differences in interpretation of the question.*

Table VIII-1

REPORTED TOTAL ASSETS--1975*

(thousands of dollars)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Mean	17	98	212	398	1,200	1,615	8,291	63,763	423,065
Standard Deviation	16	98	204	332	1,103	1,417	9,420	62,499	242,582
Median	10	70	141	307	787	1,104	6,742	43,530	372,046
(# obs.)	(40)	(100)	(55)	(75)	(46)	(30)	(63)	(178)	(9)

*Based on systems reporting a ratio of total assets to daily production of between $0.25 and $20.00.

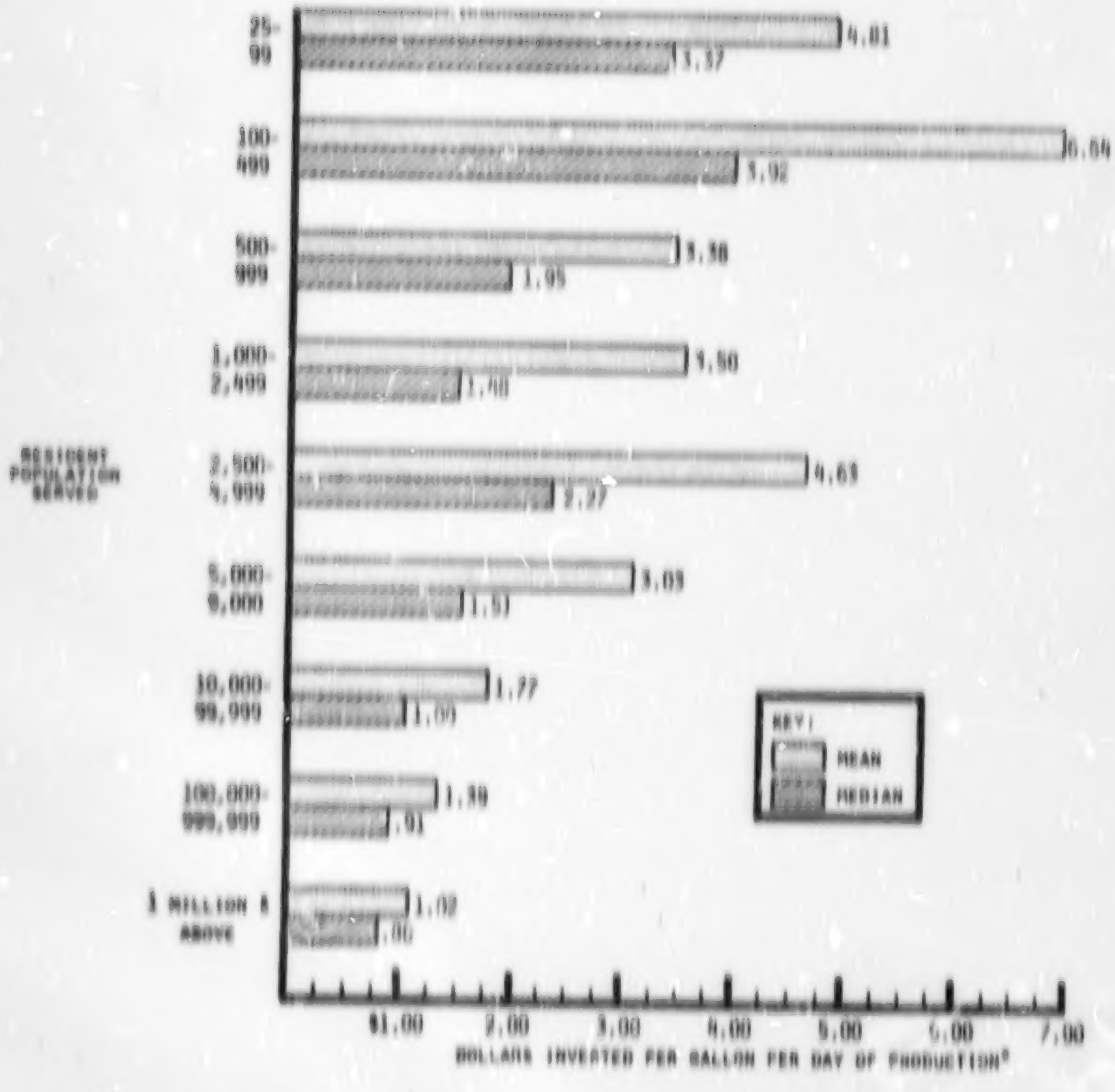
One additional point regarding reported total assets is the difference between publicly- and privately-owned systems. Publicly-owned systems reported higher total assets than privately-owned systems in all but two size categories. However, the sample size is quite small in many categories and no statistically valid conclusions can be drawn.

TOTAL ASSETS: COMPUTED

In view of the issues discussed above, tabulations were performed for each of the six individual asset questions and then summed to arrive at computed estimates of total assets. The computed total assets were tabulated on the basis of dollars invested per gallon of average day production. This tabulation permits assets to be related to system scale and also to examine economies of scale.

The results for total assets are presented graphically in Figure VII-1 on the next page. The pattern shown in the

Figure VIII-1
TOTAL ASSETS OF COMMUNITY WATER SYSTEMS
(MEAN AND MEDIAN VALUES)



*BASED ON AVERAGE DAILY PRODUCTION LEVEL AND FOR SYSTEMS REPORTING TOTAL ASSETS TO DAILY PRODUCTION RATIOS BETWEEN $0.50 AND $50.00.

figure clearly indicates that economies of scale exist in total asset requirements for water systems. Whether one focuses on the mean values or the medians, the pattern is the same: (1) that the asset requirements per gallon of average daily production are highest for the systems serving under 500 people; (2) that those requirements drop approximately in half for the systems serving 500 to 10,000 people; and (3) that they drop in half again for the systems serving over 10,000 people. Also, as evidenced in other data reported earlier, the highest figures are not those for the smallest size category, but are those for the second size category, serving 100 to 500 people.

The mean values shown for total assets are consistently higher than the median values, reflecting the existence of a few systems at much higher than average asset rates in each size category. The mean rates begin at almost $5 per gallon of average daily production for systems serving 25 to 100 people and increase to over $6 for the next size category. The mean rates then decline to $3 to $4 for systems serving up to 10,000 people and drop to $1 to $2 for larger systems. In contrast, the medians begin at $3 to $4 for the two smallest system sizes, then decline to $1 to $2 for systems serving up to 10,000 people, and finally drop to $.80 to $1.00 for larger systems.

Overall the levels of total assets are substantial. Based on the $3 or more per gallon of average day production in the size categories up to 10,000 people, a 1 MGD water system would, on average, represent more than a $3 million investment in plant, equipment, distribution system, and other assets. The lower median values are still above $3 per gallon of average daily production for the first two system sizes (up to 500 people), and above $1.50 for the next four. Based on median values, the typical 1 MGD water system represents a total investment of approximately $1.5 million in all system assets.

INDIVIDUAL ASSET ACCOUNTS: MEAN VALUES

The survey results for the six individual asset accounts are presented in terms of dollars per gallon of average day production. As illustrated in Table VIII-2, the general pattern of economies of scale observed in total assets can be seen in virtually every individual asset account.

These individual accounts are clearly dominated by the net fixed investments in plant and equipment (gross plant less depreciation). This category accounts for 80 percent of total assets for small systems and 70 percent for the largest systems. The remaining assets, for systems serving fewer than 5,000 people, are primarily composed of current assets. For larger systems "other" assets is the second major category. The difference in the relative importance of current versus "other" assets may be economies of scale in working capital on the one hand, and an in increasing amount of investment in building and equipment for administrative and organizational needs as systems increase in size on the other.

Table VIII-7

MEAN VALUES OF ASSETS--1976*

Dollars per Gallon of Average Daily Production

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	≥1 million
Gross Plant									
Production/ Treatment	1.99	1.75	.76	.71	.74	.64	.36	.32	.23
Distribution	1.94	2.99	1.79	1.16	2.79	1.74	1.15	.81	.61
Other	.98	1.14	.31	.13	.69	.33	.22	.17	.19
Total Gross Plant	4.91	5.88	2.85	2.01	4.22	2.71	1.74	1.30	1.03
Accumulated Depreciation	(1.03)	(.58)	(.50)	(.30)	(.37)	(.41)	(.30)	(.27)	(.31)
Current Assets	.84	1.16	.64	.79	.55	.28	.33	.20	.06
Other Assets	.09	.38	.31	.13	.23	.45	.12	.16	.25
Total Assets	4.81	6.84	3.30	2.63	4.63	3.03	1.77	1.39	1.03
(# obs.)**	(11)	(26)	(10)	(21)	(17)	(16)	(34)	(106)	(8)

---

*Based on systems reporting total assets to daily production between $0.25 and $20.00.

**Number of observations differs for each line item; listed is the lowest number of observations used in computing any of the 3 gross plant line items.

The plant and equipment assets are reported in four line items: (1) production-treatment plant(s) which includes the assets invested in obtaining water, in delivering it to the treatment plant, and in the treatment facility itself; (2) distribution system assets which include finished water storage, pumping, and the distribution system from the treatment plant to customers; (3) other assets; and (4) total accumulated depreciation on all fixed assets.

The relative sizes of the first three of these line items are shown in a separate table below. These line items which make up gross plant investment exhibit a very consistent relationship to one another across all system sizes. The major line item for all sizes is distribution system assets, which

Table VIII-3

GROSS PLANT ASSETS BY CATEGORY--1976

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Production-Treatment Plant	40%	30%	27%	24%	18%	24%	21%	25%	22%
Distribution System	40%	51%	62%	57%	66%	66%	66%	62%	59%
Other	20%	19%	11%	19%	16%	10%	13%	13%	19%
Total Gross Plant	100%	100%	100%	100%	100%	100%	100%	100%	100%

generally represents 50 to 66 percent of total gross plant assets. The production-treatment plants account for approximately 20 to 30 percent of gross plant assets. The smallest category is other assets which makes up 10 to 20 percent of total gross plant assets. The only deviation from this pattern in the sample is in the smallest system size category, for which production-treatment plant assets and distribution system assets were reported to be almost equal at 40 percent of gross plant assets each.

INDIVIDUAL ASSET ACCOUNTS: MEDIAN VALUES

The table of median values below shows the same patterns for the "typical" water system in each size category as the mean values do for the statistically "average" system. As noted earlier, the mean values in every category are higher than the medians because of the wide range and skewness of the responses.

Table VIII-4

MEDIAN VALUES OF ASSETS--1976

Dollars per Gallon of Daily Production

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	≥ 1 million
Gross Plant									
Production/ Treatment	1.28	.91	.56	.28	.46	.29	.23	.26	.20
Distribution	1.59	2.36	1.17	.89	1.64	1.08	.61	.72	.62
Other*	.23	.07	.22	.14	.12	.17	.09	.06	.15
Total Gross Plant	$4.05	3.60	1.95	1.31	2.22	1.64	1.13	1.03	.97
Accumulated Depreciation	(1.12)	(.33)	(.37)	(.20)	(.25)	(.30)	(.32)	(.25)	(.27)
Current Assets	.09	.43	.23	.27	.27	.33	.15	.08	.04
Other Assets	.05	.14	.09	.13	.11	.09	.04	.05	.01
Total Assets	$1.37	3.02	1.96	1.48	2.27	1.51	1.05	.91	.80
(# obs.)**	(11)	(29)	(18)	(30)	(17)	(16)	(31)	(126)	(8)

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*Based on systems reporting total assets to daily production between $0.16 and $20.00.
**Number of observations differs for each line item; listed is the lowest number of observations used in computing any of the 3 gross plant line items.

Since distribution assets generally represent over half of total gross plant assets, one further observation is worth noting since it does not follow the general theme in the financial profile of economies of scale. If the distribution systems is viewed in terms of investment per customer connection, that amount increases steadily as systems get larger. As the data below illustrates, both the mean and median values demonstrate the same pattern, the former ranging from $285 to $540 per connection from smallest to largest system size, and the latter ranging from $241 to $498. Presumably, since the number of connections increases as systems get larger, the complexity of designing and constructing a distribution system with multiple users (e.g. high rise buildings) at each connection is greater and therefore costlier.

The increasing amount of distribution assets per connection as systems become larger may be due to the characteristics of the service areas served by larger systems.

The cost of underground work in heavily developed areas and the equipment required may have an effect. Other factors may include customer mix and density of system service. These characteristics have been discussed in earlier chapters and clearly show the more varied customer mix and greater density of users per connection which occur as systems fall into larger size categories.

Table VIII-8

DISTRIBUTION SYSTEM ASSETS PER CONNECTION--1976
(dollars per connection)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	>1 million
Mean	$285	271	342	316	470	470	482	502	549
Standard Deviation	210	240	254	181	252	236	219	152	222
Median	241	331	252	286	390	430	424	468	494
(# obs.)	(26)	(50)	(27)	(44)	(13)	(20)	(42)	(133)	(8)

CAPITAL AND LIABILITIES

One important objective of the survey was to determine the capital structure of water systems. This section presents the results of questions on capital and current liabilities accounts. A complementary set of questions was also included on the specific financing of capital expenditures over the last five years; these are discussed later in the chapter.

All water systems have capital and liabilities accounts, at least in theory. By the definitions of double-entry accounting, the sources of the funds to finance construction and operations should be recorded on each system's balance sheet--long term debt reflects loans, for example, over five years in term; paid-in capital identifies shareholder investment and annexation fees; equity includes accumulated earnings; current liabilities represents short-term debt, construction advances, and accounts payable.

However, while these accounts all exist in theory, not all water systems--especially the public ones--keep their books that way. In particular, many systems apparently have not fully accounted for the original capital which financed the construction of the system. Accordingly, data presented here on the capital accounts include a category for implied other capital which is the amount required to bring the total into balance with the total assets presented earlier. This implied other capital is an estimate of the amount of capital which has gone unreported (at least on the water system books). The amount of unreported capital for small private systems is probably a mixture of equity and long-term debt since the water system cost may have been included in the total financing of the housing development or mobile home park. For the larger systems, the unreported capital is probably mostly equity, representing the original assessments, contributions and earning received over the years.

Most of the discussion of capital items is presented separately for public and private systems. On average, at least, both have approximately equal total amounts of capital (because both have very similar total asset levels), but their accounting structure is slightly different. Both have long-term debt, current liabilities, and other capital accounts. But only the private systems report paid-in capital (shareholder investment) and retained earnings. The "equity" for public systems is in the form of contributions, annexation charges, accumulated earnings, and capital assessments and are included in other capital.

LONG-TERM DEBT

One major capital account which is common to both public and private water systems is long-term debt. The initial costs of drilling wells, building reservoirs, and laying pipe in the ground has been high enough and their useful physical lives have been long enough (often in excess of fifty years) that long-term borrowing has been a very acceptable method of water system financing for decades.

The systems serving over 500 generally reported that they do have long-term debt obligations: approximately two-thirds of the systems serving 500 to 5,000 people, and between 82 and 100 percent for all the larger categories. The mean amount of long-term debt reported ranged between one-third and one-half of the mean total asset values for each of these categories. For example, the mean for systems which reported long-term debt and serve 1,000 to 2,500 people was $164,000 at the time of the survey, which is just over 40 percent of the mean total assets of $398,000 reported for the category and presented earlier in the chapter.

The median values for long-term debt are slightly lower than the mean values for each size category, and reflect the same general relationship to total assets: one-third to one-half of the median asset values.

Fewer of the small systems have long-term debt--only 18 percent (7 out of 40) systems serving under 100 people, and 46 percent (48 out of 105 systems) of those in the 100-500 category. The reason for that is the small systems may be less able to borrow money, even though they are generally newer and would be expected to have a higher frequency of long-term debt.[a] Small systems which have long-term debt appear to be more reliant upon it for total financing than are the larger systems. Systems in the second size category, 100 - 500 population, showed both mean and median levels of long-term debt equal to two-thirds of total assets: a mean level of $62,000 of debt versus $98,000 of total assets, and a median level of $49,000 versus $70,000.

The tabulated values for the systems in the smallest size category, serving 25 to 100 people, appear to be as high or higher than the mean assets reported earlier. That is because the systems in this size which do have debt tend to be larger than the average system in the category. For the systems which do have long-term debt in this size category, the average relationship of long-term debt to total assets is 61 percent, and the median is 57 percent.

Table VIII-6

LONG-TERM DEBT

ALL SYSTEMS WHICH HAVE DEBT--1976

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Percent with Long-Term Debt	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100%
Total Amount Reported[a] ($1,000)									
Mean	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Standard Deviation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Median	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(# obs.)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Amount Per Gallon of Avg. Daily Production ($)									
Mean	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Standard Deviation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Median	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(# obs.)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[a] Total Amount based on all systems reporting long-term debt greater than zero; amount per gallon of average daily production based on systems also reporting their production and with debt-to-production ratios of less than $10.

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[a] *The capital market's constraint for small private systems may be typified by the Federal Farmers Home Administration which regularly lends to small communities of under 5,000 people. To qualify for an FmHA loan, a system must: 1) be publicly-owned; and 2) "be financially sound, and able to organize and manage the facility effectively."*

The upper portion of tables VIII-6 through VIII-12 summarizes the discussion on the level of long-term debt for all size categories.

The lower portion of the table on long-term debt presents the amounts on a comparable basis across sizes, namely dollars per gallon of average daily production. The pattern, reflects the same economies of scale as in total assets. The values, for water systems which have long-term debt, range downward from over $2.60 per gallon per day of average production for the smallest systems to $0.49 for the largest ones. The standard deviation again points out the wide degree of variability in the individual system responses.

PUBLICLY-OWNED SYSTEMS

The questionnaire for public systems requested three categories of capital and liabilities, in the following order: 1) long-term debt; 2) other capital items; and 3) current liabilities. The largest response, 469 systems, was obtained on the long-term debt question. Apparently, it was clear and readily answered from water system records. The other questions received fewer responses: 350 for other capital, and 251 for current liabilities (out of 622 public systems in the final sample).

The results of these questions are shown in the table below on the comparable basis of dollars of capital and liabilities per gallon of average daily production. The values shown are the mean values for all responses, including the systems which reported zero for long-term debt or other capital items.[3] The total row shown on Table VIII-7 has been taken from assets data in Tables VIII-2 and 4, on the assumption that total liabilities equal total assets. The "impied other" capital row represents the difference between reported assets and reported capital and liabilities.

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[3] *Separate statistics for systems with and without long-term debt can be easily computed from the data in the table; long-term debt for systems which have it is the overall mean divided by the percent of systems with long-term debt; current liabilities can be assumed identical for both types; and "other" capital is the remaining difference to equal total assets.*

Table VIII-7

PUBLIC SYSTEMS
CAPITAL & LIABILITIES--1976*
(Dollars per Gallon of Average Daily Production)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	≥1 million
Percent with Long-Term Debt	6%	61%	67%	71%	60%	87%	76%	90%	100%
MEAN VALUES									
Long-Term Debt	.09	1.93	1.00	.75	.90	1.06	.52	.46	.50
Other Capital	.00	.12	.83	.29	.93	.87	.30	.40	.41
Current Liabilities	.30	1.36	.59	.44	.36	.20	.16	.10	.03
Implied Other**	4.51	3.66	1.15	2.07	3.07	1.71	.79	.44	.13
Total**	4.91	6.06	3.98	3.50	6.03	2.94	1.77	1.39	1.07
MEDIAN VALUES									
Long-Term Debt	.00	.03	.21	.08	.25	.07	.30	.31	.58
Other Capital	.00	.00	.00	.03	.00	.00	.01	.14	.48
Current Liabilities	.23	.24	.08	.07	.16	.03	.03	.03	.03
Implied Other**	3.02	2.53	1.46	1.11	1.91	.89	.67	.43	(.09)
Total**	3.37	3.02	1.91	1.40	2.27	1.51	1.40	.91	.63
(N)***	(7)	(66)	(62)	(65)	(45)	(51)	(66)	(146)	(6)

*Each row based on systems reporting dollars to average daily production ratios of zero to $10.
**Total set equal to Total Assets figures earlier in this chapter. All "implied other" capital is the difference between the reported capital and liabilities and total assets.
***No. of systems responding on long-term debt; other accounts had slightly fewer responses.

Since the total listed above has been taken from the total assets figures, it exhibits the same declining structure with increasing system size. In addition, the individual capital accounts also follow that pattern. Long-term debt for all public systems, for example, averages just under $2 per gallon of average daily production for small systems serving 100 to 500 people, declines to approximately $1 for systems serving 5,000 to 10,000 people, and further drops to 50 cents for the largest systems. The mean values for current liabilities display a similar pattern, peaking at the second size category ($1.36) and declining steadily to the largest sizes ($.10 and $.03).

In relative terms, the larger systems rely more heavily upon long-term debt for system financing than do the smaller systems. Even though the smaller systems average higher debt-to-production ratios, they have a lower percentage of their total capital and liabilities in long-term debt than the large systems do. That is clearest in the median values above, which show long-term debt as 17 percent or less of the total for systems serving 100 to 2,500 people, increasing to 30 to 37 percent for systems serving 2,500 to 1 million people, and 47 percent for systems of over 1 million population. The pattern for mean values is less clear, partly because the means represent an average of all the systems, with and without debt. The means show long-term debt to be approximately 20 to 33 percent of total capital and liabilities for all but the smallest and largest categories (zero and 50 percent, respectively).

The figures for other capital perhaps should be viewed in conjunction with the implied other capital account, which is inferred from the assets data to represent contributions and paid-in capital which have simply gone unreported. Together these accounts represent one-third to two-thirds of the total capital and liabilities of publicly-owned water systems of all sizes except the smallest, for which they represent over 90 percent.

The median values shown in the lower half of Table VIII-7 indicate that the "typical" water system in each category actually has an even higher proportion of its total capital and liabilities in the form of such unreported items (the implied other capital account). In fact, over half of the systems in each category below 10,000 population simply do not carry the original assessments and other local initial "equity" investment on their books; those systems all reported zero as their balance of "equity" in the form of other capital.

The relatively high levels of current liabilities for the two smallest system sizes probably reflects some short-term borrowing and credit used in lieu of the long-term debt used by the larger systems.

PRIVATELY-OWNED SYSTEMS

The survey questionnaire for private systems requested four items of capital and liabilities data, in the following order: 1) long-term debt (over five years); 2) paid-in capital (common stock, paid-in surplus, preferred stock); 3) retained earnings, and 4) current liabilities. The responses for these items are reported on a common basis of dollars per gallon of average daily production in the table below. An account for implied other capital is included as it was for public systems to show the difference between total assets (total from Table VIII-2) and reported capital and liabilities. As with the table on public systems, the values below are the averages of all responses, including the systems which reported zero for long-term debt, paid-in capital, or retained earnings.[4]

Table VIII-4
PRIVATE SYSTEMS
CAPITAL & LIABILITIES--1976
(Dollars per Gallon of Average Daily Production)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	≥1 million
Percent with Long-Term Debt	71%	65%	68%	56%	83%	0	84%	100%	100%
				MEAN VALUES					
Long-Term Debt	[illegible]	.77	1.90	1.40	1.41	0	[illegible]	[illegible]	[illegible]
Paid-In Capital	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Retained Earnings	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Current Liabilities	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Implied Other[b]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total[b]	4.01	6.06	5.10	5.50	4.63	[illegible]	1.77	1.90	.84
				MEDIAN VALUES					
Long-Term Debt	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]
Paid-In Capital	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Retained Earnings	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Current Liabilities	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Implied Other[b]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total[b]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(N)[c]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[a] Each row based on systems reporting dollars to average daily production ratios of zero to [illegible].
[b] Total not equal to Total Assets figures earlier in this chapter, and "implied other" capital is the difference between the reported capital and liabilities and total assets.
[c] No. of systems responding on long-term debt; other accounts had slightly fewer responses.

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[4] See footnote, page VIII-14.

Unfortunately, very few of the private systems were able to provide a breakdown of their capital accounts. Six of the nine size categories included in the table above present results based on 11 or fewer responses. The sample is statistically adequate only for systems serving fewer than 500 people and for those serving 100,000 to 1 million people. The absence of a reported value for long-term debt for systems in the 5,000 to 10,000 range certainly reflects the small sample (2 systems) systems, not the fact that systems of this size have no long-term debt.

The overall pattern of capital and other liabilities is quite similar for both private and public systems. Both rely on long-term debt for approximately one-third or less of their total financial base, with the private systems marginally lower than the public ones in most categories. Current liabilities display exactly the same pattern across size categories regardless of ownership--it peaks in the second size category, at about $1.50 per gallon of average daily production, drops to 40 to 50 cents in the next size, and then declines to less than 10 cents for the very large systems.

The paid-in capital and retained earnings accounts, taken together, are the parallel of the other capital account for public systems. The fact that the sum of paid-in capital and retained earnings is somewhat higher than the corresponding public system account may merely reflect more accurate bookkeeping, since the total of those accounts and the implied other capital is generally one-third to two-thirds of total assets, just as it was for public systems.

Perhaps the only real capital structure difference evident in this sample between public and private systems which one can infer from the data in these tables is that the small public systems more frequently rely on debt to provide capital financing than the private systems do. That is clearly indicated in the 100 to 500 population range, where samples of 59 public and 46 private systems yield percentages with long-term debt of 61 percent and 26 percent, respectively. The inference is supported by slightly lower percentages for private systems in the next two larger categories as well, and by a lower reliance on short-term credit (current liabilities) by private systems in the 100 to 500 population bracket.

CAPITAL EXPENDITURES (1970-1975)

Survey participants were asked to list major capital expenditures made since 1970. They were asked to specify these expenditures by purpose (e.g. production, treatment, distribution, storage, and miscellaneous) as well as by year and source of financing (e.g. bonds, revenue, bonds and special debt, Federal loans, new equity issues, operating surplus or other internal sources). The three major purposes of these questions were to determine: a) The overall level of capital expenditures; b) the major purposes of expenditures; and c) the most frequent sources of financing.

Over the six-year period, 1970-1975, total expenditures for all the survey participants reporting was approximately $1.9 billion dollars. As shown in Table VIII-9, the average expenditure per system over the period ranged from

Table VIII-9

TOTAL CAPITAL EXPENDITURES FOR SIX-YEAR PERIOD 1970-1975

(thousands of dollars)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	>1 million
Total Capital Expenditures 1970-1975	84.9	1,823.5	1,024.0	4,860.9	7,187.6	10,338.9	61,873.5	1,410,100.6	406,949.1
Number of Systems Reporting	42	99	35	84	29	21	56	161	8
Average Capital Expenditure per System (1970-1975)	2.02	18.4	29.2	57.9	247.6	492.3	1,098.0	9,018.0	51,116.8
Median	1.5	6.8	12.8	31.3	99.0	294.0	672.4	3,464.2	51,872.1

$2,020 for the smallest systems to $51 million in the largest size category. The median amounts were lower than the means for all but one size category.

The largest share of total expenditures by systems in every size category was that reported for distribution system improvements and extensions. As shown in Table VIII-10, that accounted for at least 45 percent for all but one system size. The other categories of capital expenditures varied in relative significance from one system size to another, apparently reflecting the periodic nature at such expenditures and the randomness of the sample. For three size categories treatment expenditures were the second highest in two cases. Expenditures listed for the storage and miscellaneous categories were under 15 percent for most system sizes with a few exceptions. However, the sample sizes were too small in many cases to draw further conclusions. Table VIII-10 illustrates the distribution of systems which reported major capital expenditures by purpose and share of the total spent over the six-year period.

Table VIII-10

CAPITAL EXPENDITURES BY PURPOSE*

(six-year period 1970-1975)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	>1 million
Percentage of Total Capital Expenditures (1970-1975) For:									
Distribution	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Treatment	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Production	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Storage	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-
Miscellaneous	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%
Number of Systems** with Capital Expenditures (1970-1975) For:									
Distribution	31	41	20	20	10	15	38	108	9
Treatment	2	5	3	5	6	5	6	14	4
Production	4	27	6	5	4	7	10	55	5
Storage	7	4	3	6	3	1	7	21	-
Miscellaneous	7	16	9	12	4	6	16	42	-

*Excludes single expenditures reported for multiple purposes.

**A single system may be counted more than once if it reported capital expenditures for more than one purpose.

While a significant share of total capital expenditures were devoted to one purpose, the source of funds for such expenditures as well as for other purposes was quite varied across size categories. However, some patterns were discernable. General obligation bonds were consistently the source for a fifth or more of the financing for all but the smallest size categories over the period. They provided as much as 59 percent of the $1.4 million spent by systems serving 100,000 to 1 million people. Federal loans were an important source for systems serving under 5,000 people, with the notable exception of the smallest category.[4] Federal assistance amounted to approximately 42 percent of the 14.7 million dollars spent by these smaller systems.

Operating surpluses and other internal sources provided a fifth to a third of the capital funds for all size categories except those serving 1,000 to 5,000 people and accounted for almost 90 percent of the smallest systems (25 to 100) sources of funds. Overall, of the total capital expenditures level of $1.9 billion dollars, 27 percent or $508 million dollars came from operating surpluses and other internal sources. External sources, then, accounted for 73 percent of total financing.

Table VIII-11 shows the financing sources reported in each of the system size categories as well as the number of systems which reported each source of financing.

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[4] *See footnote, page VIII-12.*

Table VIII-11

SOURCES OF FINANCING CAPITAL EXPENDITURES FOR SYSTEMS REPORTING SPECIFIC SOURCES*

(six-year period 1970-1975)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	> 1 million
Percentage of Capital Expenditures Financed through:									
Bonds	8.1%	39.6%	30.0%	32.6%	29.6%	26.0%	36.2%	56.9%	22.9%
Revenue Bonds and Special Debt	0	18.0%	0	5.0%	6.9%	12.7%	8.2%	14.4%	37.0%
Federal Loans	0.7%	13.5%	16.0%	30.3%	54.4%	14.3%	6.9%	0.6%	0
New Equity Issues	2.6%	5.3%	17.9%	5.0%	3.3%	0.1%	7.6%	1.3%	0.6%
Operating Surplus plus Other Internal Sources	88.6%	23.2%	25.5%	18.9%	6.0%	46.9%	43.2%	26.8%	30.0%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Number of Systems Financing through:									
Bonds	5	9	7	13	7	5	15	70	5
Revenue Bonds and Special Debt	0	1	0	2	2	2	3	19	1
Federal Loans	1	7	8	11	5	3	5	5	0
New Equity Issues	2	7	4	6	4	1	5	3	1
Operating Surplus plus Other Internal Sources	35	45	19	22	10	9	37	57	2

---

*Based upon systems reporting sources of financing; excludes multiple financing sources reported for a single expenditure.

If these major capital expenses are examined on an annual basis, most size categories had no single year in which a significant portion of their investments were made. Only two size categories, those serving 25 to 100 and 500 to 1,000 had investments in a given year greater than a third of their total expenses. Generally, 1970 appeared to have lower expenditure levels than other years. However, the sample size was quite small. Table VIII-12 summarizes the percentage of total capital expenditures made by year from 1970 through 1975.

Table VIII-12

ANNUAL CAPITAL EXPENDITURES BY YEAR*
(1970-1975)

	Population Category								
	25-99	100-499	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-99,999	100,000-999,999	≥1 million
Percentage of Total 1970-1975 Capital Expenditures Spent in:									
1970	1.2%	12.8%	7.9%	2.7%	12.8%	8.6%	2.0%	27.7%	9.4%
1971	10.9%	12.2%	6.3%	6.3%	15.9%	21.0%	16.8%	9.3%	21.9%
1972	41.2%	28.9%	5.7%	18.7%	15.4%	8.5%	10.0%	14.7%	19.3%
1973	6.5%	3.7%	13.9%	22.9%	11.0%	10.2%	27.0%	20.2%	21.8%
1974	28.6%	25.2%	38.0%	24.2%	17.6%	29.9%	22.7%	15.2%	18.0%
1975	10.0%	15.8%	29.2%	27.2%	27.7%	21.1%	18.4%	12.9%	9.6%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Number of Systems with Capital Expenditures in:**									
1970	7	14	4	8	4	5	8	39	1
1971	5	7	6	10	7	6	21	56	3
1972	7	16	6	10	7	6	24	65	3
1973	12	11	11	23	10	5	26	85	5
1974	17	27	13	21	13	10	28	75	3
1975	15	10	10	13	7	5	14	53	3

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* Excludes single expenditures reported for multiple purposes.

** A single system may be counted more than once if reported expenditures in more than one year.

APPENDIX

QUESTIONNAIRE FOR PUBLICLY-OWNED WATER SYSTEMS

A-1

PUBLIC QUESTIONNAIRE

WATER SYSTEM OPERATING, TREATMENT, AND FINANCIAL INFORMATION FORM

OMB #158-S75020
Approval Expires 10/77

INTRODUCTION: *For multiple choice questions, please "X" the box of the appropriate category. For other questions, please enter the data (gallons, dollars, etc.) in the spaces provided. If you do not have exact data available, please record your best estimate for the item in question.*

SECTION I: GENERAL INFORMATION

The EPA Inventory contains the following information about your water delivery system. If this information is incorrect, please cross it out and write in the correct information above each incorrect item.

NAME OF RESPONDENT ____________________

TITLE ____________________

NAME OF SYSTEM ____________________

STREET ADDRESS ____________________

CITY, STATE, ZIP ____________________

TELEPHONE NUMBER ____________________ YEAR SYSTEM BEGAN OPERATING ____________

1. Which of the following categories best describes the ownership structure of your system?

   ☐ 1. Owned by local government (municipal, state, district, authority, etc.)
   ☐ 2. Owned by federal government
   ☐ 3. Privately owned (investor-owned or owned by other non-government organization)

2. Total permanent residential population served directly by your system (excluding transient users and population served indirectly through wholesales):

   ____

3. How much additional residential population, if any, does your system serve on a seasonal basis (that is, population served only 2-3 months during the year)?

   ____

4. Please record the number of active service connections you have in each of the following service categories:

SERVICE CATEGORY	PLEASE INDICATE THE NO. OF ACTIVE SERVICE CONNECTIONS YOUR SYSTEM HAS IN THIS CATEGORY
TOTAL CONNECTIONS	
Residential connections	
Commercial/Industrial connections..........................	
Wholesale connections (i.e., customers who redistribute your water to other users).....	
Other (e.g., agricultural connections, municipal/institutional connections-- towns, hospitals, etc.)	

NOTE: If your system serves fewer than 25 permanent residents and has less than 15 total active service connections, you need not complete the rest of the information below. However, please return this questionnaire form to us with the information you have provided above.

TEMPLE, BARKER & SLOANE, INC.
DECISION RESEARCH CORPORATION
[illegible] STREET WELLESLEY HILLS MASSACHUSETTS 02181

SECTION II: OPERATING DATA

1. Please indicate the amount of water (in gallons) your system obtained in 1974 from each of the following sources (please indicate "NONE" if your system does not use any particular source).

SOURCES	TOTAL GALLONS SUPPLIED TO YOUR SYSTEM IN 1974
TOTAL WATER SUPPLIED TO YOUR SYSTEM FROM ALL SOURCES	____________________
Surface water....................................	____________________
Ground water	____________________
Purchased water	____________________

2. If you purchased water in 1974 from outside sources, how much of this water was...

Surface water?__________% Ground water?__________%

3. Do you plan to use any new sources of water . . .

By 1980: ☐ Yes ☐ No 1981-1985: ☐ Yes ☐ No 1986-1990: ☐ Yes ☐ No

IF YES, please indicate:

1. Type____________________ (ground, surface, purchased) Maximum Daily Use____________ (MGD) ☐ to replace existing sources ☐ in addition to existing sources

===

2. Type____________________ (ground, surface, purchased) Maximum Daily Use____________ (MGD) ☐ to replace existing sources ☐ in addition to existing sources

4. In 1974, excluding purchased water, what was the maximum number of gallons your system produced in any one day (that is, your maximum day production?

__________________gallons produced in maximum day

5. What is the maximum daily treatment capacity of your system--that is, the total gallons per day your system is designed to treat?

__________________gallons per day

6. Please indicate the total amount of water you delivered (including purchased water, if any) to each of the following types of customers in 1974. NOTE: Please include unmetered deliveries, if any, in your estimate.

SERVICE CATEGORY	TOTAL GALLONS DELIVERED IN 1974
TOTAL GALLONS DELIVERED BY YOUR SYSTEM	____________________
Residential connections...................	____________________
Commercial/industrial connections.....	____________________
Wholesale connections (i.e., customers who redistribute your water to other users)................................	____________________
Other (e.g., agricultural connections, municipal/institutional connections--towns, hospitals, etc.)............	____________________

SECTION III: TREATMENTS

1. For each of the following types of treatment, please indicate approximately how much of the water you distribute is treated by your system (i.e., do not count treatments by other systems from whom you purchase water).

% OF YOUR DISTRIBUTION WHICH RECEIVES THIS TREATMENT BY YOUR WATER SYSTEM:

TREATMENT TYPE	None	1-33%	34-66%	67-99%	All
Disinfection (chlorination,etc.)	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Coagulation	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Sedimentation	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Filtration	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Prechlorination	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Fluoride Adjustment	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Corrosion control (Ph control)	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Taste and odor (activated carbon)	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Aeration	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Lime soda softening	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Iron Removal	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Ammoniation	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Activated Alumina	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Ion exchange softening	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Other (please describe) ____________________	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐

2. Approximately what percentage of the total water you distribute receives no treatment of any type by your system? (CHECK APPROPRIATE BOX)

☐ 1. All water is treated
☐ 2. No water is treated
☐ 3. 1-33% is not treated
☐ 4. 34-67% is not treated
☐ 5. 68-99% is not treated

3. Please describe any new treatment facilities which your system has added since 1970?

TYPE OF TREATMENT PROVIDED	YEAR BEGAN OPERATION	TOTAL COST TO BUILD TREATMENT FACILITY OR ADDITION	CAPACITY OF FACILITY OR ADDITION (gallons per day)

4. Please describe any new treatment facilities or additions to existing treatment facilities which your system has definitely scheduled to begin operation before 1980?

TYPE OF TREATMENT TO BE PROVIDED	YEAR SCHEDULED TO BEGIN OPERATION	DESIGN CAPACITY OF FACILITY OR ADDITION (gallons per day)

SECTION IV. FINANCIAL INFORMATION

NOTE: PLEASE COMPLETE THE FOLLOWING INFORMATION FOR 1974 TO THE BEST OF YOUR ABILITY

Please note that the financial information needed is applicable only to water operations. If your water system is consolidated with a larger entity (for example, municipal budget, combined water-sewer operation, subsidiary of multi-system company, etc.) please try to provide your best estimate of financial information which is applicable to your local water system only. If your water system has an annual report or other financial statement, it would be extremely helpful if you could forward a copy to us with this form.

1. The following information is based on financial data for:

FROM: Month________Year________ THROUGH: Month________Year________

2. Please indicate your total revenues from water operations from each of the following service categories (include sales, hook-ups, connection fees).

SERVICE CATEGORY	TOTAL ANNUAL REVENUES FROM WATER OPERATIONS
TOTAL WATER REVENUES	____________
Residential connections	____________
Commercial/Industrial connections	____________
Wholesale connections (i.e., customers who redistribute your water to other users)	____________
Other (e.g., agricultural connections, municipal/institutional connections-- towns, hospitals, etc.)	____________

3. Please indicate budget appropriation from general fund, if any ____________

4. Based on your present rate structure, what would a typical residential customer pay:

Per year for 100,000 gal: $____________

OR Per 100 cubic feet: ____________¢

5. Is your water system required by law to obtain approval from a state regulatory agency or authority prior to raising its rates?

☐ 1. Yes ☐ 2. No

6. Are customers billed for water jointly with sewer charges or other municipal services? ☐ 1. Yes ☐ 2. No

7. Please indicate the total operating expenses (excluding interest) of your water system for 1974 and, to the best of your ability, the division of your total operating expenses among the categories listed.

TOTAL OPERATING EXPENSES OF WATER SYSTEM (excluding interest)........................ ______

Operating and Maintenance.......... ______

Other Operating Costs.............. ______

Payments in lieu of taxes (if any): .... ______

8. Please indicate 1974 debt service.......................... ______

Interest expense: .... ______

Repayment of principal: .... ______

9. If you have a sinking fund for replacement of plant equipment, please indicate amount paid into it in 1974..... ______

10. What was the operating surplus/operating deficit of your system in 1974? .... ______

SECTION V: BALANCE SHEET DATA

As in the previous section, please provide the following information about your local water system in 1974.

1. Please indicate the total assets of your water system, and to the best of your ability, the division of your total assets among the categories listed:

TOTAL ASSETS OF WATER SYSTEM (original cost) ______

Categories of Assets:

Plant and equipment (original cost)

Production-treatment plant(s).......... ______

Distribution system .... ______

All other plant and equipment .... ______

Total accumulated depreciation or sinking fund for replacement (if any) ______

Current Assets.......................... ______

Other Assets not included in the above categories .... ______

2. Please summarize the liability, capital, and other balance sheet categories listed below.

Long-term debt (over 5 years).......... ______

Other Capital Items (annexation charges, and other items not covered by the above categories).... ______

Current liabilities.................... ______

3. Please describe your major capital expenditures since 1970 (please specify production, treatment and/or distribution).

DATE	AMOUNT OF EXPENDITURE	PURPOSE OF EXPENDITURE	HOW WAS THE EXPENDITURE FINANCED	AMOUNT OF FEDERAL ASSISTANCE, IF ANY

4. Which of the following categories most closely describes the financial information available for your water system.

☐ 1. Data above is based primarily on estimates

☐ 2. Data above is based primarily on financial records applicable to the water operations of this system

H.5a

QUESTIONNAIRE FOR INVESTOR-OWNED WATER SYSTEMS

PRIVATE QUESTIONNAIRE

A-6

WATER SYSTEM OPERATING, TREATMENT, AND FINANCIAL INFORMATION FORM

OMB #158-S78030
Approval Expires 10/77

INTRODUCTION: *For multiple choice questions, please "X" the box of the appropriate category. For other questions, please enter the data (gallons, dollars, etc.) in the spaces provided. If you do not have exact data available, please record your best estimate for the item in question.*

SECTION I. GENERAL INFORMATION

The EPA Inventory contains the following information about your water delivery system. If this information is incorrect, please cross it out and write in the correct information above each incorrect item.

NAME OF RESPONDENT ____________________________________

TITLE ____________________________________

NAME OF SYSTEM ____________________________________

STREET ADDRESS ____________________________________

CITY,STATE,ZIP ____________________________________

TELEPHONE NUMBER __________________ YEAR SYSTEM BEGAN OPERATING ________

1. Which of the following categories best describes the ownership structure of your system?

   - ☐ 1. Owned by local government (municipal, state, district, authority, etc.)
   - ☐ 2. Owned by Federal government
   - ☐ 3. Privately owned (investor-owned or owned by other non-government organization)

2. Total permanent residential population served directly by your system (excluding transient users and population served indirectly through wholesales):

   ____

3. How much additional residential population, if any, does your system serve on a seasonal basis (that is, population served only 2-3 months during the year)?

   ____

4. Please record the number of active service connections you have in each of the following service categories:

SERVICE CATEGORY	PLEASE INDICATE THE NO. OF ACTIVE SERVICE CONNECTIONS YOUR SYSTEM HAS IN THIS CATEGORY
TOTAL CONNECTIONS	____________
Residential connections	____________
Commercial/Industrial connections	____________
Wholesale connections (i.e., customers who redistribute your water to other users)	____________
Other (e.g., agricultural connections, municipal/institutional connections--towns, hospitals, etc.)	____________

NOTE: If your system serves fewer than 25 permanent residents and has less than 15 total active service connections, you need not complete the rest of the information below. However, please return this questionnaire form to us with the information you have provided above.

TEMPLE, BARKER & SLOANE, INC.
DECISION RESEARCH CORPORATION
10 WALNUT STREET WELLESLEY HILLS MASSACHUSETTS 02181

SECTION II: OPERATING DATA

1. Please indicate the amount of water (in gallons) your system obtained in 1974 from each of the following sources (please indicate "NONE" if your system does not use any particular source).

SOURCES	TOTAL GALLONS SUPPLIED TO YOUR SYSTEM IN 1974
TOTAL WATER SUPPLIED TO YOUR SYSTEM FROM ALL SOURCES	______________
Surface water	______________
Ground water	______________
Purchased water	______________

2. If you purchased water in 1974 from outside sources, how much of this water was...

Surface water?__________% Ground water?__________%

3. Do you plan to use any new sources of water . . .

By 1980: ☐ Yes ☐ No 1981-1985: ☐ Yes ☐ No 1986-1990: ☐ Yes ☐ No

IF YES, please indicate:

1. Type______________________ (ground, surface, purchased) Maximum Daily Use______________ (MGD) ☐ to replace existing sources ☐ in addition to existing sources

2. Type______________________ (ground, surface, purchased) Maximum Daily Use______________ (MGD) ☐ to replace existing sources ☐ in addition to existing sources

4. In 1974, excluding purchased water, what was the maximum number of gallons your system produced in any one day (that is, your maximum day production?

_______________gallons produced in maximum day

5. What is the maximum daily treatment capacity of your system--that is, the total gallons per day your system is designed to treat?

_______________gallons per day

6. Please indicate the total amount of water you delivered (including purchased water, if any) to each of the following types of customers in 1974. NOTE: Please include unmetered deliveries, if any, in your estimate.

SERVICE CATEGORY	TOTAL GALLONS DELIVERED IN 1974
TOTAL GALLONS DELIVERED BY YOUR SYSTEM	______________
Residential connections	______________
Commercial/Industrial connections	______________
Wholesale connections (i.e., customers who redistribute your water to other users)	______________
Other (e.g., agricultural connections, municipal/institutional connections--towns, hospitals, etc.)	______________

SECTION III: TREATMENTS

1. For each of the following types of treatment, please indicate approximately how much of the water you distribute is treated by your system (i.e., do not count treatments by other systems from whom you purchase water).

TREATMENT TYPE	% OF YOUR DISTRIBUTION WHICH RECEIVES THIS TREATMENT BY YOUR WATER SYSTEM: None	1-33%	34-66%	67-99%	All
Disinfection (chlorination, etc.)	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Coagulation	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Sedimentation	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Filtration	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Prechlorination	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Fluoride Adjustment	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Corrosion control (Ph control)	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Taste and odor (activated carbon)	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Aeration	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Lime soda softening	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Iron Removal	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Ammoniation	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Activated Alumina	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Ion exchange softening	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐
Other (please describe) ______________	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐

2. Approximately what percentage of the total water you distribute receives no treatment of any type by your system? (CHECK APPROPRIATE BOX)

☐ 1. All water is treated
☐ 2. No water is treated
☐ 3. 1-33% is not treated
☐ 4. 34-67% is not treated
☐ 5. 68-99% is not treated

3. Please describe any new treatment facilities which your system has added since 1970?

TYPE OF TREATMENT PROVIDED	YEAR BEGAN OPERATION	TOTAL COST TO BUILD TREATMENT FACILITY OR ADDITION	CAPACITY OF FACILITY OR ADDITION (gallons per day)

4. Please describe any new treatment facilities or additions to existing treatment facilities which your system has definitely scheduled to begin operation before 1980?

TYPE OF TREATMENT TO BE PROVIDED	YEAR SCHEDULED TO BEGIN OPERATION	DESIGN CAPACITY OF FACILITY OR ADDITION (gallons per day)

SECTION IV. FINANCIAL INFORMATION

NOTE: PLEASE COMPLETE THE FOLLOWING INFORMATION FOR 1974 TO THE BEST OF YOUR ABILITY

Please note that the financial information needed is applicable only to water operations. If your water system is consolidated with a larger entity (for example, municipal budget, combined water-sewer operation, subsidiary of multi-system company, etc.) please try to provide your best estimate of financial information which is applicable to your local water system only. If your water system has an annual report or other financial statement, it would be extremely helpful if you could forward a copy to us with this form.

1. The following information is based on financial data for:

FROM: Month______ Year______ THROUGH: Month______ Year______

2. Please indicate your total revenues from water operations from each of the following service categories (include sales, hook-ups, connection fees).

SERVICE CATEGORY	TOTAL ANNUAL REVENUES FROM WATER OPERATIONS
TOTAL WATER REVENUES	
Residential connections	
Commercial/Industrial connections	
Wholesale connections (i.e., customers who redistribute your water to other users)	
Other (e.g., agricultural connections, municipal/institutional connections--towns, hospitals, etc.)	

3. Based on your present rate structure, what would a typical residential customer pay:

Per year for 100,000 gal: $________

OR Per 100 cubic feet: ________¢

4. Is your water system required by law to obtain approval from a state regulatory agency or authority prior to raising its rates?

☐ 1. Yes ☐ 2. No

5. Are customers billed for water jointly with sewer charges or other municipal services?

☐ 1. Yes ☐ 2. No

6. Please indicate the total operating expenses (excluding interest) of your water system for 1974 and, to the best of your ability, the division of your total operating expenses among the categories listed.

TOTAL OPERATING EXPENSES OF WATER SYSTEM (EXCLUDING INTEREST) ________

Operating and Maintenance ________

Depreciation and amortization of plant and equipment ________

Federal taxes ________

State taxes ________

Local taxes ________

Other operating costs ________

7. Please indicate the total debt service .... __________ =

Interest expense .... + __________

Repayment of principal .... + __________

8. What was the net profit or loss of your system in 1974 (or most recent 12-month period)? __________

9. Please indicate the amount of dividends paid to stockholders, if any. __________

SECTION V. BALANCE SHEET DATA

As in the previous section, please provide the following information about your local water system at the close of your most recent accounting period. A copy of your most recent financial statement, if available, would be extremely helpful.

1. Please indicate the total assets of your water system, and to the best of your ability, the division of your total assets among the categories listed:

TOTAL ASSETS OF WATER SYSTEM (ORIGINAL COST)............................ __________

Categories of Assets:

Plant and equipment (original cost)

Production-treatment plant(s) .... __________

Distribution system .... __________

All other plant and equipment .... __________

Total accumulated depreciation.......... __________

Current Assets:................................ __________

Other Assets not included in the above categories:............................ __________

2. Please summarize the liability, capital, and other balance sheet categories listed below.

Long-term Debt (over 5 years) .... __________

Paid-in capital (common stock, paid-in surplus, preferred stock) ... __________

Retained earnings (accumulated surplus) .... __________

Current liabilities .... __________

3. Please describe your major capital expenditures since 1970.

DATE	AMOUNT OF EXPENDITURE	PURPOSE OF EXPENDITURE	HOW WAS THE EXPENDITURE FINANCED	AMOUNT OF FEDERAL ASSISTANCE IF ANY

4. Which of the following categories most closely describes the financial information available for your water system.

☐ 1. Data above is based primarily on estimates

☐ 2. Data above is based primarily on financial records applicable to the water operations of this system

CODING PROCEDURES

The procedures and conventions followed in transferring data from questionnaires to coding forms are described briefly below. The section and question numbers refer to the questionnaires.

SECTION I - GENERAL INFORMATION

Q #1: Was checked to make sure that no federally-owned systems were included and that publicly-owned systems had completed a yellow questionnaire and privately-owned systems had completed a white questionnaire.

Q #2: The number here was checked against the number of connections in Question 4. Quite frequently the answers to these two questions were the same. In these cases the respondent was called back. If the respondent could not estimate total permanent residential population, the residential connections in Question 4 were multiplied by 3.17 (the average household size according to the 1970 U.S. Census).

Q #3: Was coded "zero" if left blank.

Q #4: Blank lines were coded "zero" if the rest of the categories added up to the total. If not, blank lines were left blank.

SECTION II - OPERATING DATA

Q #1: If left blank, the system was recontacted to determine water source. For those few systems that could not be recontacted, this question was left blank.

Q #4: Figures were checked against Question 6 since some systems recorded daily deliveries on Question 6 rather than deliveries for the entire year.

Q #5: Figures were checked against Section III and purchased water figures were used to help distinguish between treatment performed by the supplying wholesale system rather than by the system completing the questionnaire.

Q #6: Total gallons delivered were checked against total gallons supplied. Any substantial discrepancy which could not be explained by "loss" resulted in recontacting the respondent for clarification.

SECTION III - TREATMENT

Q #1: Most respondents left treatment types blank rather than checking the "none" category if they did not use that type of treatment. Therefore, unless the entire question was left blank, blanks were recorded as "none." If Question 1 was completely blank, Question 2 was checked and, if they answered "no water is treated," all sections of Question 1 were recorded as "none." If they did treat their water and had not answered Question 1, the respondent was recontacted to determine the type of treatment.

All treatments named under "other" were summarized by type and included where appropriate in one of the fourteen existing categories or coded as "other."

Q #2: Was checked for consistency with Question 1.

Q #3 & 4: All treatments not listed on Question 1 were summarized and included in one of the fourteen categories as appropriate, or coded as "other." A "multiple treatments" code was added to account for several treatments combined on one line. Capital expenditures for additions to the system which were clearly not for treatment were excluded from Question 4. Expenditures for non-treatment additions on Question 3 were transferred to Section V - Question 3 if they were not already included there.

SECTION IV - FINANCIAL INFORMATION

A number of systems included a financial statement rather than completing Sections IV and/or V. Those questionnaires were forwarded to TBS where financial information was transferred to the questionnaire and returned to DRC for coding.

Q #1: If the time period was less than or greater than twelve months, the questionnaire was forwarded to TBS where adjustments were made in the appropriate figures and returned to DRC for coding. For example, an 18-month fiscal year would result in multiplying operating expenses and revenues by 2/3.

Q #4: When rate schedules were provided, TBS determined the typical yearly rate for 100,000 gallons and returned the questionnaire to DRC for coding.

Q #8: Figures here were checked against Section V - Question 2 since many systems recorded their entire debt service on Question 8, line 1. When this occurred, Question 8, line 1, was changed to reflect the total of Question 8, lines 2 and 3.

Q #10: Figures here were assumed to be surpluses unless otherwise indicated by parentheses, minus sign, underlining "deficit," or crossing out "surplus."

SECTION V - BALANCE SHEET DATA

Q #1: Current assets were checked against total assets. If the two were identical, the current assets line was left blank.

Q #2: Current liabilities were checked against long-term debt. If the two were identical, the current liabilities line was left blank.

Q #3: Responses were coded as production, treatment, distribution, miscellaneous, and multiple. All responses not clearly fitting into one of these groups were summarized and given to TBS for final resolution and coding instructions. If more than four entries were made, responses were combined by: 1) method of financing; 2) purpose of expenditure; and/or 3) year, depending on the breakdown provided by the system.

All questions left blank and not clarified by calling back the respondent were left blank on the coding form unless the answers could clearly be deduced from other responses or written comments.

Seventy-four questionnaires which were returned were not included in the final data base for the following reasons:

3 = refused to provide any information

7 = were not community water systems

2 = were federally-owned

2 = had seasonal population only

35 = had less than 25 permanent residents

6 = were no longer in operation

11 = did not provide enough data to include them and could not be recontacted

3 = were unable to complete the form

5 = had miscellaneous other problems

ADDITIONAL SOURCES OF INFORMATION ON WATER SYSTEM FINANCES

American Water Works Association, *Operating Data For Water Utilities 1965, 1970*, an AWWA Statistical Report, 1971.

Holt, A. and D.L. Chambers, "An Updated Hartford Metropolitan District Water Rate Survey," *Journal American Water Works Association* (August 1976).

Luthin, John C., "Rate Making Practices of State Regulatory Commission," *Journal American Water Works Association* (September 1976).

Moberg, Walter J., Jr., *The Cost of Supporting Rural Water Systems--Projections and Policies*. Commission on Rural Water. Chicago, Illinois: Information Clearinghouse 1976.

National Association of Water Companies, "Financial Summary For Investor-Owned Water Utilities 1973, 1974." Prepared under NAWC Economic Research Program.

U.S. Environmental Protection Agency, Unpublished Case Studies on Cost of Water Supply. Prepared under contract to Water Supply Research Division, Cincinnati, Ohio (1975-1976).

Wright, John D. and Don R. Hassal, "Trends in Water Financing," *The American City*, (December 1971 and January 1972), Parts Two and Three of a ten-part series on Modern Water Rates. Part One (November 1971) and Parts Four-Ten (February - September 1972) may also be of interest.

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